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ANOMALOUS PROJECTION AND OTHER VISUAL PHENOMENA ASSOCIATED WITH STRABISMUS

F. H. VERHOEFF, M.D.

BOSTON

The purpose of this communication is to correct what I believe to be misconceptions concerning certain visual phenomena associated with strabismus by pointing to significant facts hitherto overlooked or disregarded. These misconceptions are so prevalent that their correction is of considerable importance. Of the misconceptions in question, probably the most misleading relate to anomalous projection.

Before this remarkable phenomenon can be intelligibly discussed, it is essential that a precise definition of corresponding retinal points be given. Many such definitions have been attempted, some of which are evidently inaccurate, while others are inadequate or ambiguous.[1] The following definition, which, so far as I know, has never previously been definitely expressed, has certain advantages, particularly for the purpose of discriminating between normal and anomalous projection. With the head stationary, fix with one eye (for the present assumed to be the right) the center of any suitable object, *A*, as in figure 1, in external space. (In this diagram, the objects, each of suitable size, are indicated by their centers.) The primary visual axis of the right eye will now intersect that of the left eye at some point, *P*. In the case of a person with binocular fixation, *A* and *P* will coincide, but in the case of a squinter, *A* is supposed to be so placed as not to coincide with *P*. It is, of course, assumed that after fixation of *A* has been

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From the Howe Laboratory of Ophthalmology, Harvard University, and the Massachusetts Eye and Ear Infirmary.

1. A definition that corresponding retinal points are retinal points which are projected to the same place in space does not include the case in which an image on one retinal area is projected 6 inches (15 cm.) away and an image on the corresponding area is projected 6 miles (9,656 meters) away. On the other hand, as will be seen later, a definition that corresponding retinal points are retinal points that are projected in the same direction does not distinguish between normal and anomalous projection. The definition at which I arrive avoids these and other difficulties.

attained by the right eye, both eyes remain stationary. Select any other object, *N*, in the binocular field. The image of *N* in the right eye is centered on a certain retinal point, *r*. Place another object, *C*, so that its retinal image in the right eye is also centered at *r*. The line *NC* is defined as the visual axis of *r* and also as the right visual axis of *N*. With both eyes open, place an object, *D*, so that as seen from the left eye its center appears in line with the centers of *N* and *C* as seen from the right eye. (That any particular objects are seen only from a designated eye can be assured when necessary by the use of suitable screens [2] or in other obvious ways that do not require detailed description.) The image of *D* in the left eye is centered at a certain retinal point, *r'*. Place another object, *E*, so that its retinal image in the left eye is also centered at *r'*. If it is now found that the centers of the objects *D* and *E* as seen from the left eye appear in line with the centers of the objects *N* and *C* as seen from the right eye, *NC* and *DE* are corresponding visual axes, and *r* and *r'* are corresponding retinal points.

Observations in numerous cases have demonstrated that when any two visual axes thus correspond they do so only with respect to each other and continue to do so for all positions of the eyes, whether or not these positions are attained by changes in the motor innervation. Therefore, within the binocular field, for each of the various visual axes in one eye there is one and only one corresponding visual axis in the other eye, and corresponding retinal points have fixed anatomic positions on the retinas.[3] It has also been found that when retinal correspondence exists, the axes ordinarily considered to be primary visual axes are corresponding visual axes. That retinal correspondence always means that the correspondence is fixed accords with all previous conceptions of retinal correspondence.

The foregoing definitions may be more concisely stated as follows: A visual axis is defined as any line in external space, all suitable objects centered on which have their retinal images centered at the same retinal

2. The introduction of a suitable screen to obstruct from one eye only the view of an object does not necessarily establish unusual conditions. Similar conditions often exist in ordinary vision, for instance, when a tree obstructs only from one eye the view of a more distant object.

3. This brings up the questions of Panum's areas and the so-called fusion of disparate images, but for the purpose of the present communication these are unimportant. I have discussed them elsewhere (A New Theory of Binocular Vision, Arch. Ophth. **13**:151 [Feb.] 1935) and have explicitly denied that "fusion" of disparate images ever occurs. One experienced in precise stereoscopic observations can easily ascertain that the "fusion" in question in reality consists in complete replacement of one of a pair of disparate images, not by the other image (as may occur in the case of corresponding images) but by the part of the visual field represented on the other retina in the area exactly corresponding to the area occupied by the image replaced.

point.[4] This point is termed the retinal optical terminal of the visual axis concerned.

Corresponding visual axes are defined as any two visual axes that as visualized from their respective eyes with the aid of suitable objects appear to coincide. The imaginary line in which they thus appear to coincide is termed a binocular visual axis.

Corresponding retinal points are defined as the retinal optical terminals of a pair of corresponding visual axes.

The question as to the apparent position of any binocular visual axis is complex but does not require discussion in this communication. Noncorresponding retinal points are called disparate points. Retinal correspondence in normal eyes is so precise that under suitable conditions disparateness of less than 1 second of arc may be recognized as difference in depth.[5]

In normal binocular vision the primary visual axes intersect at the point of binocular fixation. Because of torsional deviations and other factors, the other corresponding axes seldom actually intersect, as do *DE* and *NC* at *K* in figure 1, but cross above or below each other. For present purposes, however, as well as for many others, it can be assumed that they nearly intersect. The surface in which they most nearly do so is the observer's horopter for the fixation point concerned.[6]

It is commonly believed that in certain cases of strabismus a condition develops that is usually termed anomalous retinal correspondence, in which corresponding retinal points are abnormally related, so that the macula of the fixing eye corresponds not to that of the squinting eye but to some other fixed retinal area in that eye, called the false macula.[7] This conception is indicated by the expression "anomalous correspondence adapted to the angle of squint," used by Bielschowsky.[8] That the conception is erroneous in its fundamental assumption that

4. Possible slight effects of changes in accommodation and pupillary size on a visual axis need be taken into account only when exceptionally high precision is required, and for present purposes they may be disregarded.

5. Anderson, E., and Weymouth, F.: Visual Perception and the Retinal Mosaic, Am. J. Physiol. **64**:561, 1923.

6. The surface on which objects situated on the horopter appear to the observer to be located may be termed his subjective horopter. The horopter and the subjective horopter may or may not coincide in whole or in part. The discrepancy between the two may differ for different persons and for the same person under different conditions and at different times. The question of the location of the subjective horopter closely concerns that of aniseikonia.

7. The prevalence of this misconception is shown by the fact that it is held by the writers of standard textbooks, including Duke-Elder (Textbook of Ophthalmology, London, Henry Kimpton, 1932, vol. 1, p. 1030). T. Travers, in his recent monograph (The Comparison Between Methods Employed for the Treatment of Concomitant Strabismus, London, George Pulman & Sons, Ltd., 1936), sets forth this misconception as if it were an established fact.

8. Bielschowsky, A.: The Etiology of Squint, Am. J. Ophth. **20**:478, 1937.

fixed retinal correspondence exists in the cases referred to can be conclusively demonstrated by the method just used for defining corresponding retinal points. For in such cases of strabismus, whether convergent or divergent, I have found by this method not only that the primary visual axes do not correspond to each other but that each of various visual axes in the squinting eye, including the primary visual axis and even the axis of the "false macula," has no corresponding axis in the other eye. I have found also that this holds true for various

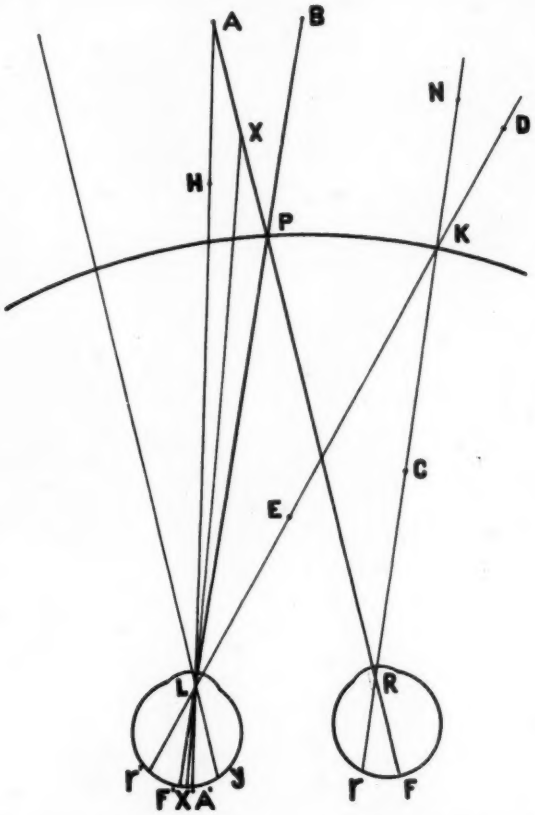

Chart 1.—Diagram for explaining corresponding visual axis, corresponding retinal points and anomalous projection.

positions and therefore presumably for all positions of the eyes. Hence in such cases there are no corresponding visual axes and consequently no corresponding retinal points.[9] It is to be noted that in binocular vision, when there is correct projection in the cases under consideration, the object *D* seen from the left eye only (fig. 1) will be placed on and

9. This fact was demonstrated by me in a somewhat different fashion thirty-six years ago (The Theory of the Vicarious Fovea Erroneous, Ophth. Rec. **10**:300. 1901).

appear to lie on the line *NC*, and the object *E* will appear to lie not on this line but in its correct position.

In such cases, therefore, the type of binocular projection differs fundamentally from that of a normal person and the term anomalous type of binocular projection (or, for the sake of brevity, anomalous projection) may properly be applied to it. Although this term is not as descriptive as is desirable and hence may continue to be misunderstood, I retain it because it is in somewhat common use. Anomalous projection may now be explicitly defined as a type of binocular projection in which there are no corresponding visual axes, or as a type of binocular projection without retinal correspondence. The terms anomalous correspondence, abnormal correspondence and false macula are clearly misleading, since in the cases of strabismus to which these terms are applied there is no fixed retinal correspondence to be anomalous or abnormal.

It is commonly assumed that anomalous projection exists only in unusual cases. I have not attempted to demonstrate it in children under 8 years of age and have not persisted in the attempts to do so in a few patients whose replies were obviously unreliable. But, with these exceptions, I have been able invariably to demonstrate anomalous projection in numerous persons with established concomitant strabismus. I have found also that anomalous projection may occur in persons with sursumvergent strabismus, but at present I am unable to state the frequency with which it occurs.

The question now arises as to the meaning of the term "normal retinal correspondence." Obviously, for the purpose of distinguishing between the vision of the nonsquinter and that of the squinter, the term need imply only the existence of corresponding retinal axes and corresponding retinal points, without regard to the positions of these axes and points; hence the prefix "normal" is unnecessary.[10] If "normal" means that the primary visual axes correspond, it is again unnecessary, since when other axes correspond the primary visual axis of one eye always corresponds to the axis that is regarded as primary in the other eye, at least for binocular vision. Although, so far as I know, all authors dealing with the subject have failed to define corresponding retinal points with explicit reference to corresponding visual axes, it is clear from the context of their papers that when they speak of retinal correspondence they at least mean that the correspondence is fixed. Since existence of corresponding visual axes is a normal characteristic, it constitutes the normal type of binocular projection. Since retinal

10. A patient with ordinary unilateral paralytic strabismus, who is otherwise normal with respect to the eyes, has retinal correspondence but abnormal binocular projection. The binocular projection, although of the normal type, is abnormal in that it is incorrect, but since the primary and other visual axes correspond, it is not anomalous.

correspondence exists only when there is correspondence of visual axes, it is the normal type of retinal correspondence. Hence correspondence of visual axes, normal type of binocular projection, retinal correspondence and normal type of retinal correspondence are synonymous terms. Of course, "type of" and "binocular" may be omitted when they are unequivocally implied by the context of an expression. For special purposes, the term normal retinal correspondence could be used to designate the condition in which the horopter closely agrees with some horopter, such as the Hering-Hillebrandt, assumed to be normal.

It may now be well to emphasize certain facts, obvious from the foregoing considerations. The precision with which a visual axis can be determined depends on the visual acuity of each eye and on the sizes of the two test objects and their distances from the eyes. If the distinctness of the images is disregarded, the nearer *C* (fig. 1) is and the farther *N*, the more precise the determination. Actually, however, the distinctness of the images cannot be disregarded. Practically, therefore, *C* and *N* must be of such sizes and placed at such distances as are suitable for the accuracy required. Anomalous projection is dependent on the existence of an interocular distance. As a mathematical concept, if this distance were zero, anomalous projection could not exist. When the test objects are all beyond a certain considerable distance from the eyes, the method described for determining anomalous projection is inapplicable, since the actual interocular distance is too small in relation to the visual acuity. When the test objects are at suitable distances, which are easily determined (usually about 10 cm. for near objects and 6 meters for distant objects), the discrepancy revealed by the test is either so slight or so great that correspondence or lack of correspondence of the visual axes concerned is at once apparent. Hence the distinction between retinal correspondence and anomalous projection is not relative but as nearly absolute as any subjective distinction can be.

From the evidence at hand, it seems safe to assume that to distinguish between retinal correspondence and anomalous projection it is simply necessary to ascertain either that the primary visual axes correspond within narrow limits or that they do not correspond within wide limits. This may easily be done by the method just described. If the primary visual axes seem to correspond within wide limits, this can mean only that the visual acuity concerned is too low for the observations to be of significance in regard to the type of projection. For this reason, in cases of high grade amblyopia it may be necessary to test some axis other than the primary axis of the squinting eye.

Another method for demonstrating anomalous projection is afforded by the subjective "cover test," commonly used for determining heterophoria. This is applicable in all cases of strabismus except the rela-

tively few in which the ocular deviation is less than about 20 prism diopters. This method is perhaps even simpler than that described, and when the results are positive it is equally conclusive. The squinter is asked whether or not an object which he is fixing at a distance of 5 meters or more appears to change its position or to move when a cover is quickly transferred from one eye to the other. If, as is usually the case, the object appears unchanged in position, anomalous projection obviously exists, for the primary visual axes do not correspond. This is also true if, as determined by a suitable prism, apparent change in the position of the object differs from the angle of strabismus by as much as 10 prism diopters. Owing to possible undetected fluctuations in the amount of ocular deviation, the method cannot be relied on to determine the nonexistence of anomalous projection or the existence of retinal correspondence. If in the rare case of a person without obvious squint but with anomalous correct projection marked strabismus should supervene as the result of trauma or paralysis, the cover test might fail to demonstrate the existence of the anomalous projection, since a prism that would compensate the actual deviation would also compensate the subjective deviation. Here the first-described method would be required.

For persons with normal vision, no change in the apparent positions of objects occurs with change in fixation, provided there is no change in convergence. This is true also of persons with anomalous projection; when the cover is transferred from the squinting eye, the object of chief attention continues to appear in its correct position whether or not it is then fixed by this eye. To the squinter the only significance of change in fixation by the squinting eye seems to be that he is "looking" with this eye.

To demonstrate perhaps still more clearly the fallacy of the usual concept of anomalous projection, a typical case of convergent strabismus may now be investigated as follows: Let the right eye fix a distant object, A (fig. 1). The primary visual axis of the left eye will intersect or nearly intersect that of the right eye at some point, P, determined by the angle of strabismus, which point for convenience may be designated the crossing point of the eyes. The position of this point varies to a greater or less extent with the accommodation and the distance of the object—facts that will be considered later. It will now be indicated by the cover test, and possibly also by the diplopia test and the nonius method, that A seems to be in the same place in space no matter from which eye it is seen. According to usual concepts, it must be assumed that the retinal points F and A' are corresponding points. But now substitute for A another object, X, anywhere on the line AR or its continuation. It is found that X also appears to be in the same place in space whether seen from the right or from the left eye. Moreover,

it is never seen double. Therefore, also according to usual concepts, F and X' must be corresponding retinal points. And even when X is placed at P, it still appears to be in the same place when seen with the right eye as it does when seen with the left eye, and therefore the two foveas must be corresponding points. Thus, according to usual concepts, F must correspond to all retinal points in the left eye from y to F', comprising the entire angle of strabismus. In other words, the retinal position of the false macula must vary through this wide range. Obviously this is an absurdity if it is assumed, as it always has been, that corresponding retinal points have fixed retinal positions. The truth is, as already explained, that in cases of anomalous projection there are no corresponding retinal points. As will be pointed out later, from a point of view not hitherto held, quasi corresponding retinal points may be said to exist in such cases. This demonstration also makes clear the inadequacy of the definition that corresponding retinal points are retinal points that are projected to the same place in space.

With the tests usually employed to determine whether "normal retinal correspondence" or "anomalous retinal correspondence" exists, an image is thrown on the fovea of one eye, and an image of a different kind, whether from the same object or not, is thrown on the other retina at the fovea or elsewhere. These conditions obviously are highly abnormal, since in eyes with ordinary vision every object in the binocular field is represented on both retinas and by similar images. Moreover, with most of these tests there are inadequate monocular criteria of distance in at least one eye. These unusual conditions may lead to uncertain, unreliable or inconsistent interpretations, particularly when there is anomalous projection. Thus when the test with the Maddox rod is used, the subject may state that the two images appear separated laterally, and yet much to his embarrassment he may be unable to state positively which is to the right of the other. With the after-image test strongly advocated by Bielschowsky,[11] and accredited by him to Hering, similar unusual conditions obtain, and criteria of distance are inadequate for each eye. With any of these tests, if two images, one on each fovea, appear to the subject to be superimposed or one directly behind the other, this does not conclusively prove the existence of retinal correspondence, for one or both of the images may be projected to the crossing point, whether or not the subject believes otherwise. However, if the two images are seen separated laterally in space, it is certain that the subject is manifesting anomalous projection, but the amount of the apparent separation, however measured, is not a reliable indication of the accuracy of the projection under usual conditions.

11. Bielschowsky, A.: (*a*) Application of the After-Image Test in the Investigation of Squint, Arch. Ophth. **17**:417 (March) 1937; (*b*) Untersuchungen über der Sehen der Schielenden, Arch. f. Ophth. **50**:406, 1900.

In this connection it is to be noted that instruments such as the stereoscope, including the haploscope and the amblyoscope, introduce conditions so abnormal that the results obtained with their use are often difficult to interpret or to correlate with the ordinary visual phenomena of normal persons or of squinters. In general, it is safe to say that the simpler the means employed in the investigation of visual functions, the more reliable are the results. It will no doubt be evident that in my own investigations I have endeavored to adhere to this principle.

A common assumption, which I believe to be erroneous, is that a distinction between alternating and nonalternating strabismus is of fundamental importance.[12] I have found that almost all persons with concomitant strabismus in whom neither eye is so amblyopic that it is incapable of central fixation can be taught in a few moments to alternate. It is simply necessary while the subject is viewing a distant object to cover one eye and then the other and at the proper time to say, "Now you are looking with the right eye, now with the left." After this has been repeated a few times, often only two or three, the subject can fix with either eye at command while keeping both eyes open and can also correctly designate the fixing eye. How he does this, he is unable to describe. When the object of fixation is at the crossing point, the subject may be unable to designate the eye with which he is fixing or may state that he is looking at the object with both eyes. Occasionally a squinter also makes the latter statement even when the object is at a distance. A person who has acquired the habit of ascertaining with which eye he is "looking" only by closing one eye is difficult to teach to alternate, for after many attempts he may still persist in closing one eye when asked to designate the eye with which he is "looking" or when asked to "look" with one or the other eye. When the angle of strabismus is slight, it may also be difficult to teach alternation. Whether or not a squinter naturally alternates no doubt depends chiefly on the extent to which the efficiency of one eye exceeds that of the other. However, alternation is probably of real importance in preventing amblyopia and also possibly of importance in protecting one eye from occasional peculiarities, for instance unilateral nystagmus,[13] which might ensue were this eye continually deviated.

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12. L. C. Peter (Extra-Ocular Muscles, Philadelphia, Lea & Febiger, 1936, p. 208) tabulates five criteria which, he contends, set apart "essentially alternating strabismus" as a distinct class. These criteria do not seem sufficiently definitive to sustain his classification. The assumption that in general the earlier in life strabismus is established the more difficult it is to induce normal ocular relations seems to explain his inability to obtain or develop "fusion" in the cases concerned and also to be more reasonable than his contention.

13. Verhoeff, F. H.: A Case of Unilateral Nystagmus Benefited by Treatment, Ophth. Rec. **16**:517, 1907.

A prevalent misconception is that the squinting eye ordinarily plays no part in vision, except possibly outside the binocular field, but constantly "suppresses" the retinal images from all objects in the binocular field. Thus Bielschowsky [8] recently stated: "In the latter case [normal correspondence] the suppression prevents diplopia, whereas in the former [anomalous correspondence adapted to the angle of squint] it prevents the advantage that would be gained by the anomalous correspondence." That this advantage is not prevented and that the squinting eye plays an important part in binocular vision I have demonstrated by the following four tests, which I have employed in many cases of strabismus, convergent and divergent:

The first test, which is also another simple and conclusive test for anomalous projection, I have thus far used only in cases in which the visual acuity was not below 0.5 in either eye. A small letter, *A*, is drawn on a small piece of white cardboard. This is held beyond the crossing point [14] at any convenient distance, and the subject is told to look steadily at it and not to look elsewhere. A different letter, *B*, of the same size, on another piece of cardboard, is now placed at the same distance away and approximately in the primary visual axis of the squinting eye. It is moved about until the subject says he sees it most distinctly. He is then able to name it. If the squinting eye is now covered, the *B*, or a different letter substituted for it, is no longer legible. The squinter, with both eyes uncovered, when asked to state with which eye he is seeing *B* usually designates the nonsquinting eye. If he is asked if he is seeing both letters simultaneously, he answers in the affirmative. If he is asked if the two letters appear the same distance apart, or nearly so, when seen with either eye alone or with both eyes open, he also answers in the affirmative, thus affording further evidence that in such cases an object appears in the same place no matter from which eye it is seen. If he has learned to alternate or has been taught to do so as described here, similar results are obtained when either eye is used for fixation.

With the foregoing test, the squinter in a sense is fixing with both eyes, although on a different object with each eye. Yet he will state that he is "looking at" *A*, not at both *A* and *B*, whether or not he is able to designate with which eye he is doing so. Another significant fact is that when his attention is called to *B*, he manifests a desire, which is sometimes irresistable, to fix it with the nonsquinting eye. However, if he has learned to alternate and is requested to look at *B* with the squinting eye, he promptly does so, as is evidenced by a slight ocular movement when this is necessary to center the image of *B* on

14. In a case of divergent strabismus, of course, the crossing point of the primary visual axis is an imaginary point situated behind the eyes.

the fovea of this eye. Incidentally, from these observations it is obvious that the fixing eye cannot always be determined by asking a squinter with which eye he is "looking." The simplest way to ascertain this is to ask him to designate the object at which he is looking, and then for the observer to note which eye is directed toward this object. Objectively, the fixing eye can be determined by ascertaining on which fovea movement of the image causes movement of fixation.

With the second test, which consists simply of application of the first test to areas other than the foveas, fixation is steadily maintained on any convenient object. Another object, for instance the letter *B*, is carried across the binocular field, and at suitable intervals comparisons are made as to the apparent distinctness of this object, or its legibility, and its apparent position when seen in binocular vision and when seen from each eye separately without change in fixation.

The third test, employed to show that in cases of strabismus both eyes play an important part in vision, is equally simple. A red transparent screen is placed before the fixing eye, and a green transparent screen, before the other eye. The subject is instructed to maintain fixation on a small object situated at a distance of about 1 meter and usually, therefore, well beyond the crossing point, even if the strabismus is convergent. A white disk, 21 mm. in diameter, on a black background is now placed just above or to one side of the point of fixation. To the subject it appears red. It is then placed on the primary visual axis of the squinting eye at about the same distance away. Now it appears green. It is then slowly carried across from this position toward the other. When at an intermediate position, while still appearing to be the same object seen with the same eye, it suddenly appears red, without sudden change in its apparent position. Evidently the position at which it appears to change color indicates the line which at the time divides the visual field seen by one eye from that seen by the other. In no case did the statements of the squinter indicate that there was binocular mixture of colors, even when the disk was placed at the crossing point. When the disk was placed there, it was never described as yellow, although rivalry in colors sometimes occurred. However, it should not be inferred that binocular mixture of colors is impossible for persons with strabismus, for this phenomenon is often difficult to demonstrate even in normal subjects. In some cases of strabismus Bielschowsky [11b] obtained the appearance of violet from red and blue when the test object was far beyond the crossing point.

The fourth test affords an interesting demonstration of the part played by the squinting eye in binocular vision under abnormal conditions, a part similar to that played under the same conditions by the normal eye. The test is carried out by the aid of an ordinary stereo-

scope from which the median partition has been removed so as to permit each eye to see both fields. If through such an instrument a normal person views a stereoscopic card on which are two similar circles, one centered before the right eye and the other centered before the left eye, he will see three circles: a middle circle unified by the two eyes and on each side of it a circle seen monocularly. A squinter also usually thus sees three circles, except that the middle circle is consciously seen from the fixing eye only. If the fixing eye is the right eye and the circle on the right is red and that on the left green, the squinter will see a red circle in the middle, a red circle on the right and a green circle on the left. For the normal subject, the middle circle will show rivalry between red and green or will appear yellow. From the results of the foregoing tests the following conclusions can be drawn concerning the vision of squinters with anomalous projection:

1. Ordinarily both eyes are used in binocular vision.

2. Usually in binocular vision each object is consciously seen only from the eye from which it could be the more distinctly seen in monocular vision without change in fixation. This means, of course, that as a rule when the two eyes are nearly equal in visual acuity the eye from which an object is consciously seen is the eye whose retinal image of the object is nearer the fovea. This rule applies also when the squinting eye is highly amblyopic, except in the case of objects whose retinal images in the squinting eye fall within the amblyopic area. Of course, the rule may not hold when by artificial means the two images of an object are given decidedly different attention values, for instance, when to one of the images is imparted motion, flicker, color or an intensity different from that of the other image. No doubt there are other special or highly unusual conditions under which the rule may not hold.

3. Whether or not there is amblyopia, there are in each eye certain large retinal areas the images from which are constantly replaced in ordinary vision.

4. To the squinter, all retinal images simultaneously presented that are consciously seen appear to be seen simultaneously, no matter to which eye any of these images belongs. Hence an image on one fovea and another image on the other fovea appear to be seen simultaneously even when, as is ordinarily the case, they appear separated laterally in space and each is completely seen. (The special case of an object situated at the crossing point will later be considered at length.)

5. The squinter reacts as if, and will usually state that, each object in the binocular field is seen from the fixing eye only, no matter from which eye it is consciously seen.

It is as difficult for a person with normal binocular vision to imagine some of the visual phenomena of the squinter as it is for a color-blind

person to imagine the appearances of colors. For instance, a normal person cannot imagine any conditions under which it could be impossible to determine which of two images seen horizontally separated was to the right of the other, yet under certain artificial conditions the squinter is unable to do this. Nor can a normal person imagine that two images, or after-images, one on each fovea, under any conditions could be simultaneously seen as if separated laterally in space. As a matter of fact, a normal person actually can see completely two such images as if separated laterally in space, but he cannot simultaneously thus see them. For example, he can fix an object, *A*, with the right eye alone, and then an object, *B*, at one side of it, with the left eye alone. Under these conditions, *A* and *B* appear to remain unchanged in position, as they actually are, but the subject is aware that they are not seen simultaneously, that the apparent distinctness of each letter has changed and also that he has moved his eyes. In the case of a squinter with the image of *A* on one fovea and that of *B* on the other, *A* and *B* appear to be seen simultaneously without movement of the eyes and with unchanging distinctness. It is evident that before an attempt is made to understand the visual phenomena peculiar to the squinter it is necessary to disabuse the mind of many notions derived from a study of normal binocular vision. Failure to do this has led to misconceptions.

There is no more reason to doubt the statement of a squinter that two images, one on each fovea, are seen simultaneously as if from the fixing eye alone than to doubt the statement of any person that two separate images actually in the same eye are seen simultaneously. At present there is no evidence to disprove either statement. Nevertheless, regardless of these impressions of the squinter himself, it has been assumed that images on the two foveas are not actually seen simultaneously.[15] This assumption gives rise to a conception of the vision of the squinter that at first may seem to be simple and satisfactory; this is, when certain images are seen from one eye, the images that would correspond to them in the other eye if there were retinal correspondence are completely replaced, and alternating replacement of one image by the other occurs with such rapidity and frequency that the time intervals concerned are not perceived. There is evidence that complete replacement can normally occur with this rapidity, at least as regards small retinal areas, but none that it can ever occur with this frequency. And to explain why every object is seen in its correct position, no matter from which eye it is seen, and also why the squinter believes that he is seeing from one eye alone, it is necessary to assume as occurring coincident with each replacement an equally rapid and

15. Javal, E.: Manuel théorique et pratique du strabisme, Paris, G. Masson, 1896, p. 277.

consciously unperceived change in the correlation of the sensory with the unchanged ocular motor mechanism. The conception would seem to require that each object one image of which is on or near one macula and the other image of which is at a distance from the other macula be seen distinctly and then very indistinctly in rapid alternation and that this should give the object a blurred appearance. Thus the conception, on further consideration, requires so many unsupported and complex assumptions that it becomes unreasonable.

Not only does the squinting eye play an important part in binocular vision, but it provides certain advantages not possessed by the normal person. All squinters with anomalous projection, except those with amblyopia, make simultaneous use of two regions of distinct macular vision in the binocular field beyond the crossing point, and even when the squinting eye is highly amblyopic they have abnormally high visual acuity in certain portions of the field toward which the squinting eye is directed. In cases of divergent strabismus the outer field is, in addition, enlarged on the side of the squinting eye, so that objects approaching from this side must be seen sooner and more distinctly than by the person with normal vision. In cases of convergent strabismus of ordinary degree, I have ascertained that each blindspot is replaced by an image that is abnormally distinct. This is so because the replacing images are abnormally near the foveas. As will be obvious later, the squinter does not have to contend with physiologic diplopia. The effort and fatigue associated with the complicated function of binocular fixation are entirely lacking. It is probable that these advantages often offset the lack of delicate binocular depth perception. However, they do not often offset the disadvantages of the associated cosmetic defect or in cases of amblyopia compensate for the lack of a reserve eye with good central vision.

Since the term anomalous as applied to binocular projection refers only to the type of projection, it carries no implication as to the correctness of the projection. Obviously there may be anomalous correct or anomalous incorrect projection, depending on the correctness of the monocular projection. I find that usually in cases of anomalous projection, even when the squinting eye is amblyopic, the projection is substantially correct. Thus I find that if while the nonsquinting eye is fixing a convenient object another object is so placed before the squinting eye as to be seen more distinctly with both eyes open than with the fixing eye alone, and then a median partition is placed so as to exclude the second object from the fixing eye only, the two objects appear in about the same relative positions as they do when the partition is removed and also as they do when both objects are seen with the fixing eye only.

It is evident in a case of anomalous correct projection that from each eye used alone all images are projected with respect to each other

and with respect to the eye itself as correctly as monocular criteria of depth permit. If such projection were maintained when both eyes were in use, objects would be seen from two different points of view at one time, all approximately in their correct positions. This may seem impossible, yet if it did occur it would probably be no more difficult to explain than the familiar fact that when both eyes are occluded one object touched by the two hands is ordinarily correctly perceived as one object in one place. What actually happens in cases of strabismus, whether or not the projection is correct, is that the apparent absolute positions of all images that reach consciousness from the squinting eye are determined by the projection of this eye, while their apparent relative positions are judged from the point of view of the fixing eye. Although it is difficult to understand how such localization can be accomplished, that it is accomplished can be easily verified by asking the subject to define the relative positions of various objects. For example, in a case of anomalous relatively correct projection, let the right eye fix the distant object, *A*, and place *H* so that as seen from the left eye it appears in line with and just below *A* when the right eye is occluded (fig. 1). Then with both eyes open and *H* excluded from the view of the right eye by a median partition, *H* appears no longer in line with but to the left of *A*, as if *H* were being seen from the right eye only. If in a case of divergent strabismus the effect of incorrect projection is now produced by placing a suitable prism, base in, before the left eye, *H* is seen from the left eye only and still appears to the left of *A*, even when *A* is seen from this eye. To insure *A's* being seen from the left eye, it may be necessary to employ a suitably placed screen. In a case of convergent strabismus, with the prism base in it may be impossible, owing to the indistinctness of the retinal images, to insure *A's* being seen from the left eye even by means of a screen, but *H* appears to the left of the new position of *A*, estimated from the strength of the prism.

In the case of retinal correspondence, monocular depth criteria (such as size) have nothing to do with determining the direction of any monocular or binocular visual axis, that is to say, with determining the apparent angular direction of any object. In the case of anomalous projection, however, monocular depth criteria derived from the squinting eye, even when binocular criteria are removed by means of a suitable screen, can determine the apparent direction of an object as seen from only that eye in binocular vision. As concerns any object well within the binocular field, the visual axis of a retinal image in the squinting eye intersects innumerable visual axes of the fixing eye. To which of these intersections the image is projected, and hence in binocular vision along which axis of the fixing eye it is projected, monocular depth criteria derived from the squinting eye can determine. Thus whether *A* and

B (fig. 1) are projected to their actual locations or to the crossing point *P* can depend solely on monocular depth criteria. This analysis reveals one of the fundamental distinctions between the projection of a person with fixed retinal correspondence and that of a person with anomalous projection. The possibility that "suppressed" retinal images may play a part in determining the accuracy of anomalous projection will be considered later.

As already indicated, it is commonly believed or implied that "suppression" or, as I have termed it, replacement,[16] is an unusual or abnormal phenomenon and one that is manifested especially by the squinting eye. As a matter of fact, without it every normal person would see double all objects other than the relatively few that lie on the horopter. By many it is believed that when both eyes are open the entire binocular portion of the visual field of the squinting eye is "suppressed" by this eye. That this is not so and that "suppression" ordinarily occurs in both eyes simultaneously are clear from the fact, already pointed out, that both eyes simultaneously play an important part in vision. It is even maintained that one of the important steps in developing "fusion" is teaching "simultaneous macular perception," that is to say, "teaching the macula of the squinting eye not to 'suppress.'" Presumably by "fusion" is meant binocular fixation, and I [16] have pointed out that in normal binocular vision this ordinarily takes place while one of the retinal images concerned is completely suppressed. If by "fusion" is meant the seeing of two images as one image, then it is to be said that "suppression," partial or complete, instead of being disadvantageous is essential to this process.[16] Whether or not simultaneous macular perception could be demonstrated in a person with ordinary vision by means of an instrument such as the amblyoscope, it certainly existed in all of the many persons with strabismus without marked amblyopia on whom I employed the "A and B test." In such persons the real abnormality consists not in lack of simultaneous macular perception, for there is no such lack, but in the facts that both images are seen completely and that ordinarily one is seen laterally separated from the other in space.[17]

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16. Verhoeff, F. H.: A New Theory of Binocular Vision, Arch. Ophth. **13**:151 (Feb.) 1935.

17. Many of the assumptions on which orthoptic training is said to be based no doubt appear fallacious to those who, from a purely scientific and also from a practical point of view, have given years of consideration to the subject of binocular vision. These assumptions include those discussed in the present communication. Yet because the methods employed may be based on false premises, it does not necessarily follow that they are without value for the purposes intended. Their real value can be ascertained only by a truly scientific analysis of the results obtained.

It has always been assumed that "suppression" in cases of strabismus in which there is anomalous projection is the same process as the "suppression" which occurs when there is fixed retinal correspondence. When "suppression" is said to occur in a person with normal vision, what is actually taking place is the process I have termed replacement.[16] Replacement implies that when an image from one eye disappears from consciousness the image from the corresponding retinal area in the other eye is sent to consciousness; when an image from the macula of one eye is replaced, the image seen instead is always that from the macula of the other eye. When replacement is partial, as it often is, one retinal image is seen to the same extent that its corresponding image is not seen. In cases of strabismus ordinarily the images on the two maculas are from two different objects, and when there is good central vision in each eye neither image is "suppressed," whereas both of the other two retinal images of these objects are completely "suppressed" and moreover occupy different retinal positions under different conditions. Except possibly when an object is situated at the crossing point, "suppression" in cases of strabismus is always complete. Since, in general, the positional relations of the retinal areas concerned in "suppression" in cases of strabismus are variable and entirely different from those concerned in replacement, it is evident that the nervous connections involved in the two processes are also different. For objects beyond the crossing point, "suppression" analogous to the replacement which explains binocular luster,[16] and possibly also binocular color mixture in a normal subject, has never been demonstrated in a subject manifesting anomalous projection. In view of these important facts, it is clear that "suppression" in a person with anomalous projection differs fundamentally from that occurring in a person with normal vision. I shall therefore designate it by the term quasireplacement.

In this connection it should be borne in mind that even when not consciously perceived, stimuli from a retina are normally subconsciously effective somewhere in the brain. For certainly, as I have shown elsewhere,[16] replacement of one of a pair of disparate images does not prevent their producing appropriate depth effect, even though the replacement is so complete that the subject is unconscious of the existence of the replaced image and by no effort of will can see it. It is perfectly conceivable that under certain abnormal conditions the subconscious effectiveness of a retinal image might be abolished in certain respects, whether or not the image was consciously perceived. This, of course, is known actually to be true for the reactions of the pupils to light. In addition to the quasireplacement associated with anomalous projection, it is therefore necessary also to distinguish from replacement

suppression of a still different kind, operating as an abnormal process at a lower level. This process I shall term subconscious visual suppression. "Replacement," because it indicates a normal process, cannot be properly used as a substitute for "suppression" in this term.

The process of replacement provides for corresponding retinal points a definition different from that already described and also different from any definition hitherto employed. Owing to this process, an image from a retinal area in one eye partially or wholly obscures an image from the corresponding retinal area in the other eye and under no conditions ever obscures the image from any other retinal area. Thus in binocular vision a distant object can obscure the view of a near object. (As a matter of fact, it can also do this in monocular vision, for instance, when a distant object is viewed through a transparent picture.) Hence corresponding retinal areas may be defined as any two retinal areas so related, under all conditions only to each other, that an image from one area always partially or wholly obscures an image from the other. This definition does not conflict with that previously given and, as will be obvious later, is of considerable value in connection with the question of diplopia. It is also of value in the determination of corresponding retinal points, but it is of no value in determining the nonexistence of retinal correspondence, that is to say, in determining the existence of anomalous projection, because when obscuration is complete, as it always is in cases of anomalous projection, except possibly for objects in a surface passing through the crossing point, and as it may be in cases of retinal correspondence, the image that is obscured cannot be identified. Since obscuration is thus always complete in cases of anomalous projection, the simple demonstration that two retinal images either of which is projected considerably beyond or nearer than the crossing point partially obscure each other suffices to prove that the retinal areas on which the images lie are corresponding retinal areas.

In cases of anomalous correct projection, the cover test shows that each object situated beyond the crossing point appears to maintain the same absolute position when alternately seen from one eye and then from the other. Hence the two retinal images of the object correspond in the sense that each is projected to the same place in space. From a theoretic standpoint, therefore, it can be assumed that in binocular vision, although one of the images is not then consciously seen, the retinal areas on which they lie correspond temporarily. The reason why one image is not seen may be assumed to be that it is completely obscured by the other, so that theoretically the areas also correspond temporarily on the basis of obscuration. But since when an object is moved along a monocular visual axis of one eye the position of its retinal image in the other eye constantly changes yet the two images

continue to correspond as before, it is evident that the retinal correspondence in question is not fixed but variable. However, as it concerns all objects beyond a certain considerable distance it can be said to be fixed.

Such retinal correspondence differs essentially from true retinal correspondence not only in its variability but in at least one other important respect, namely, that the visual axes of the assumed corresponding retinal points do not correspond. Hence it is obligatory that it be designated by a term that unmistakably distinguishes it from true retinal correspondence. I shall therefore designate it quasi retinal correspondence. Anomalous projection can be defined as a type of binocular projection in which there is quasi retinal correspondence. This definition, however, offers no practical advantage over that previously given, since it suggests no method of demonstration simpler or more conclusive than that required for demonstrating correspondence or lack of correspondence of visual axes.

The extreme delicacy of binocular stereopsis indicates that the brain can make even finer discriminations between disparate retinal points than it can between different points in the same retina. The subjective cover test also indicates fine discrimination between disparate retinal points, since in cases in which there is retinal correspondence it elicits apparent motion of the object of fixation with deviations of a small fraction of a degree. As pointed out previously, for objects all beyond a certain considerable distance from the eye quasi retinal correspondence in a case of anomalous correspondence is, in a sense, fixed. But with the cover test, in a case of anomalous projection the strength of the weakest prism that will produce apparent change in position, or apparent lateral motion of a distant object, is never less than about 6 prism diopters and is sometimes 20 prism diopters or more. This poor discrimination, since it is not confined to persons with strabismus of sufficiently high degree, cannot be explained by the low visual acuity of the peripheral retinal area concerned. Hence the subjective cover test reveals another important difference between retinal correspondence and quasi retinal correspondence. This difference would seem to be adequately explained by assuming that quasi retinal correspondence is dependent on correlation of motor factors with retinal position and other monocular criteria, whereas retinal correspondence is dependent on retinal position alone. On the basis of the poor discrimination revealed by the cover test in cases of quasi retinal correspondence, it cannot be inferred that the apparent angular separation of two simultaneously presented distant objects one of whose consciously perceived images is on one fovea and the other on the other fovea is judged with an inaccuracy of at least 6 prism diopters. As a matter of fact,

actual tests show that the inaccuracy is far less than this, for the objects appear the same angular distance apart as when seen simultaneously from one eye alone.

Intimately related to questions that arise in connection with the foregoing observations is the following phenomenon: With the objective cover test, when a prism is used which partly or wholly compensates the squint it is usually found that when the cover is transferred from one eye to the other the uncovered eye before achieving exact fixation of the test object makes a movement as if the squint had been considerably overcorrected. The phenomenon can often be observed also without the use of a prism in cases in which the squint has been recently corrected or reduced by operation. While no doubt this phenomenon is generally familiar, its possible significance seems to have been overlooked. The uncovered eye makes an anticipatory movement as if it expected to find the object in the same place in which it had been seen by the other eye and had sought for the object here before becoming aware of the change, produced by the prism or by the operation, in its position relative to the eye. The phenomenon may occur even when the change in position is not consciously perceived, that is to say, when it is only subconsciously perceived. It is clear that the phenomenon accords with the fact that in cases of anomalous correct projection objects simultaneously presented appear located correctly in space no matter from which eye they are seen. It is also clear that the phenomenon indicates the existence of intricate and relatively precise correlations among the sensory mechanisms of the two eyes and the conjugate ocular motor mechanism. Obviously the phenomenon affords strong evidence of the existence, or previous existence, of anomalous projection.

The term diplopia is regarded as synonymous with double vision and is commonly defined as the seeing of one object as two objects. It seems to me this definition is inadequate and that two types of diplopia should be distinguished, which may be termed disparate and corresponding diplopia. They may be demonstrated to a person with normal binocular vision by having him look at a distant textured wall and then hold a finger a short distance in front of his eyes. He may then see two fingers and through each finger a portion of the textured wall. Seeing the single finger as two fingers is disparate diplopia; seeing the textured wall through one finger is corresponding diplopia. Another demonstration of corresponding diplopia is afforded by the "bar reading test." In this type of diplopia there is double vision in that two different images on corresponding retinal areas are seen simultaneously, partially obscuring each other. These two types of diplopia may be defined as follows:

Disparate diplopia is simultaneous visual perception of two retinal images that do not appear to obscure each other and that actually originate from the same external spatial area, or that are so interpreted.

Corresponding diplopia is simultaneous visual perception of two retinal images that appear partially to obscure each other.[18]

It would seem that these definitions are sufficiently exclusive and yet include all visual phenomena that may be usefully classified as diplopia. Of course, no definition can be more than relatively perfect.

Disparate diplopia includes not only the seeing of one object as two objects but other phenomena not ordinarily thought of as diplopia. Thus it includes such phenomena as seeing during the Maddox rod test a small round light and a streak of light, both actually originating from the same light source, and also the visual phenomenon elicited when through the use of a stereoscope two actual objects each seen with only one eye are interpreted as one actual object seen as two. Corresponding diplopia includes the seeing of two different objects one behind the other when they are not actually so situated with reference to either eye or to any point between the eyes. It also includes seeing one object whose retinal images have been made different by artificial means as two objects one behind the other. No doubt corresponding diplopia often causes the afflicted person as much "abhorrence" as, if not more than, does disparate diplopia, to which the term diplopia is generally restricted. Often both types of diplopia occur at the same time. In cases of anomalous projection disparate diplopia often may be easily elicited by the use of prisms and may occur after operation, but it seems impossible that corresponding diplopia could ever occur except under artificial conditions.

With one exception, it can be said that in the squinter with anomalous correct projection, diplopia analogous to physiologic disparate diplopia never occurs in the absence of binocular fixation. Thus when the squinter looks at a distant object while holding a finger before his eyes, he never sees two fingers. The exception to this is the case of a convergent squinter without amblyopia who is fixing an object placed nearer than the crossing point. Here the squinter often observes disparate diplopia of the object. The explanation of this would seem to be that the squinter is subjected to conditions which he is unable correctly to interpret, owing to the lack of sufficient experience, since one image of the object is to the outer side of the other fovea. For the divergent squinter,

18. It is to be noted that these terms and definitions apply as well to monocular as to binocular diplopia. Objection may be raised to them on the grounds that diplopia has hitherto meant only what I have described as disparate diplopia. The same objection could be made to the terms light water and heavy water, but it is now generally recognized, at least among scientists, that the unmodified term "water" is insufficiently descriptive.

retinal images so situated do not cause diplopia, because they have such positions for all objects to which he directs his attention, and hence his experience is adequate for correct interpretation of the images. In other words, for the divergent squinter an object cannot be placed nearer than the crossing point, because this point is behind the eyes. However, if a divergent squinter can fix a near object binocularly, when doing so he may observe physiologic disparate diplopia of a distant object even though he is still manifesting anomalous projection.

As already indicated, usually before operation, in a case of strabismus in which there is anomalous projection the projection is as nearly correct as the monocular criteria could permit. After operation, especially if binocular fixation is still absent, the anomalous projection persists and for a time is incorrect, since objects as seen with the eye which has been operated on appear incorrectly located. It would be expected that during the period of readjustment there would be conflict between the old projection and the projection that is being newly acquired. That this is actually so is indicated by the fact that if the various tests described here are employed a few months after operation the results obtained in some cases are so inconsistent that they are difficult if not impossible to interpret. As would also be expected, after operations for strabismus there may be postoperative disparate diplopia, which occasionally is highly annoying and in rare cases is of long duration, even permanent. Before operation, except in the unusual case of an object situated at the crossing point, images on or near the fovea of each eye are from different objects, and are all completely seen with nonamblyopic eyes with anomalous projection. Hence after an operation which corrects or nearly corrects the squint, when there is an image on the fovea of the fixing eye and an image of the same object on or near the fovea of the other eye, both images are seen for a time. Their apparent distance apart is determined by the apparent distance of the object from the original crossing point of the eyes and by the degree of the original squint. For similar reasons, other objects may also be seen double. In unusual cases there may be postoperative disparate triplopia and even monocular disparate diplopia. No doubt these are usually due to persistence of the old anomalous projection, now incorrect, along with the development of new and correct projection. Permanent postoperative disparate diplopia and triplopia seldom if ever occur in young children, no doubt because the anomalous projection has not become well established before operation and because children readily adapt themselves to new conditions. That these phenomena are rare even when the operation is performed relatively late in life shows that a person with strabismus who is otherwise normal can readily alter his projection. The fact that a few squinters cannot thus adapt themselves indicates that they are abnormal not only in having strabismus but also

in some other respect. Inability to adapt themselves to new conditions is a characteristic of persons with psychoneurosis, and, as a matter of fact, I have observed that many persons with persistent postoperative disparate diplopia have obvious psychoneurotic tendencies.

The question of amblyopia now arises. The statement that amblyopia is a frequent cause of strabismus is undoubtedly true. The statements that strabismus is a cause and that it is a frequent cause of amblyopia are still disputed, but I shall accept both as true. Amblyopia resulting from strabismus is generally believed to be due to long-continued "suppression" of images from the squinting eye. It has been assumed, no doubt correctly, that at the onset of the strabismus there is diplopia, or at least visual confusion, which is soon overcome by "suppression." If the "suppression" is continued, it is believed to cause amblyopia. In the cases in which amblyopia does not occur, it is assumed that constant "suppression" has been prevented by alternation or that its duration has been short, owing to early development of anomalous projection. In favor of this hypothesis is the fact that in many cases the amblyopia is largely abolished by long occlusion of the "good" eye. The amblyopia involves the macular region of the squinting eye and sometimes also the region within which the image of the object of chief attention usually falls. Obviously, as concerns the object of chief attention, "suppression" in both regions would do away with the two types of diplopia defined previously. The hypothesis, however, presents three difficulties. The first of these is that to overcome diplopia of all objects in the binocular field "suppression" (replacement) could not be limited to the two retinal areas mentioned. The second difficulty is that even when amblyopia has been prevented and anomalous projection established, "suppression" (now really quasireplacement) of the images in certain large retinal areas continuously occurs without causing amblyopia of these areas. The third difficulty is in assuming that either the normal process, replacement, or quasireplacement could cause amblyopia. Certainly the latter could not do so, since it continually occurs in cases in which amblyopia is not present. These difficulties are overcome by the assumption that amblyopia is caused by neither of these processes but by subconscious visual suppression. This assumption is strongly supported by the frequently observed facts that at the onset of squint the child does not complain of diplopia yet has some vague visual disturbance, as indicated by frequent closure of the squinting eye. This is sometimes true even in the case of paralytic squint occurring in an older person. The patient may say that he has no diplopia yet state that he has well marked visual disturbance. In general, visual disturbance resulting from strabismus is due to disparateness of images which under normal conditions would not be disparate and to an abnormal degree of disparateness of all other images. If both of any two disparate

images are consciously perceived, there is diplopia. In the case of the squinting child and also in the case of the older person referred to, the diplopia has been overcome by replacement, and the remaining visual disturbance must be attributed to the continuing subconscious effects of the replaced images. If this disturbance disappears in turn, it is reasonable to suppose that its disappearance is due either to the development of anomalous projection or to suppression of the subconscious effects of the images from the squinting eye, that is to say, to subconscious visual suppression. When this occurs, it, instead of replacement, is assumed to abolish the conscious perception of the images. If this abnormal suppression soon becomes unnecessary because of the development of anomalous projection, it ceases entirely and amblyopia does not result. On the other hand, if the subconscious visual suppression is not frequently interrupted by alternation or is not soon made unnecessary by anomalous projection, the suppression persists in some degree even in monocular vision and there is amblyopia of the squinting eye. The fact that amblyopia does not occur in cases of paralytic squint, even in the unusual cases in which the vague visual disturbance disappears in spite of the lack of anomalous projection, perhaps is explainable on the assumption that subconscious visual suppression is not persistent in older persons because their nervous systems are relatively stable. Conversely, disregarding the factors of anomalous projection and alternation, the earlier the onset of concomitant squint, the more likely amblyopia will result. The varying extent to which amblyopia is overcome by the development of anomalous projection, or can be overcome by occlusion of the better eye, may be accounted for by variability, dependent largely on age, in the degree of persistence of subconscious visual suppression or by actual injury which this abnormal process may cause to the visual mechanism.

The usual theory as to the cause of the amblyopia associated with strabismus is often expressed by the term amblyopia from disuse—amblyopia ex anopsia. Since it is believed by those who hold this theory that disuse of the squinting eye means normal "suppression," this method of expressing the theory is really no different from saying that "suppression" is the cause of amblyopia. This theory postulates that loss of vision is due merely to persisting suppression of the activity of the visual sensory mechanism of the squinting eye, with resulting injury to this mechanism. The theory that I have just advanced postulates that it is not this suppression per se but persistence of an abnormal subconscious process which causes it that produces amblyopia.

The question may be asked, How can visual images not consciously perceived cause visual disturbance? The answer is that such images normally send valuable information which consciousness accepts and acts on, and hence when this information does not accord with other infor-

mation, it causes confusion. If it is then asked in what respects and to what extent the information furnished by the images just considered does not accord with other information, the answer is that the information they furnish is greatly at variance with that supplied by the correct monocular criteria from the fixing eye, if only because it indicates that the objects from which the images originate are situated at distances which differ greatly from those indicated by the monocular criteria. In the case of convergent strabismus it indicates that the former distances are much greater than the latter; in the case of divergent strabismus it indicates that they are much less than the latter. Moreover, the subconscious information indicates that in the first case less and in the second case more accommodation is required to make the objects distinct than consciousness actually finds necessary. It seems probable that the visual disturbance resulting from all of this conflicting information due to images not consciously perceived is more unpleasant and more likely to cause symptoms, such as nausea, than mere diplopia of images that are consciously perceived. Diplopia if not associated with this conflicting information might be regarded by the affected subject as a pleasing and interesting phenomenon were it not for the difficulty in deciding which of two similar objects was the real object and were he not aware of the possible serious portent of the phenomenon. As a matter of fact, physiologic diplopia is generally so regarded.

As is well known, in certain cases of amblyopia the amblyopic eye employs for monocular vision an eccentric retinal area which in binocular vision seems to be roughly adapted to the angle of squint. In some cases the visual acuity of this area is higher than that of the real macula, and it has even been assumed that it may be abnormally high for such a portion of the retina. If this assumption is true, it goes to show that quasireplacement may even enhance visual acuity. An eccentric retinal area used for monocular fixation can in a sense be regarded as a false macula. But as regards binocular vision, it does not accord with the common conception of a false macula, for it does not under all conditions "correspond" with the real macula, or, in fact, with any fixed retinal area in the other eye.

The function of convergence is always an important factor in cases of strabismus, and in many cases of convergent squint associated with hypermetropia it undoubtedly has been the most important causative factor. After strabismus has been established, the function persists, although it is then evidently valueless and perhaps even detrimental to the accuracy of projection. The function of accommodation seems to be inextricably associated with what is called voluntary convergence as distinguished from adduction and abduction. In some cases of strabismus accommodation is associated with an abnormally great, and in others with

an abnormally small, amount of convergence. Normally, the sense of nearness, however produced, causes some convergence, even when the need of accommodation is abolished by means of convex glasses, and this seems to be true also in some cases of strabismus. To what extent, if any, the function of convergence impairs the accuracy of projection in cases of strabismus I have not determined.

There now arises a question, possibly of considerable importance, which has already been touched on. This relates to the conscious perception of an object placed at the crossing point in the case of a convergent squinter with anomalous projection correct for this spatial position. Obviously the conditions here are similar to those existing for a person with binocular fixation who is in the same position as the squinter and is fixing the object. The question is, under these conditions, whether in the case of the squinter replacement similar to that of a normal person occurs. I have attempted to answer this question by the aid of a contrivance that I call a replacement tester. In the center of a piece of white cardboard, about 10 cm. square, is cut a circular hole, 14 mm. in diameter (fig. 2). Extending backward from the middle of the hole is a vertical partition, about 18 cm. long, the right side of which is red and the other side of which is green. Perpendicular to the partition and attached to the distal end of it is a black screen, about 10 by 20 cm. The contrivance, kept placed so that the partition is approximately in the median interocular vertical plane, is moved back and forth until the hole is at the crossing point of the eyes. This can be assured by alternately covering one and then the other eye and noting that no movement of fixation occurs. As seen with the right eye alone, the right half of the hole appears red, the left half black, and as seen with the left eye alone, the left half appears green and the right half black. To a normal person with both eyes open, the hole sometimes appears as seen with the right eye alone, and sometimes as seen with the left eye alone, but sooner or later the right half appears red and the left green at the same time. Often rivalry between black and color is observed on one or both sides. With this contrivance, I have tested many convergent squinters, excluding those with poor vision and those in whom I was able definitely to elicit binocular fixation by other means. In almost all of the cases in which the test was employed, replacement, judging by the statements of the subject, similar to that often observed by a normal person was obtained, at least momentarily, when the hole was at the crossing point. When the hole was carried farther away, it appeared as when seen with the fixing eye alone; when it was brought nearer this was also true, or it was seen double. When in addition to esotropia there was hypertropia of considerable degree, the test failed, evidently because there was no crossing point.

While in the case of the squinter as regards the hole considered as an entire object there undoubtedly occurred incomplete replacement exactly similar to that which may occur in a person with normal vision, it is to be noted that the replacement really consisted in complete replacement of relatively large areas. In normal replacement, areas completely replaced may be as small as the smallest visual units and may be distributed in almost every conceivable way. In an area such as that

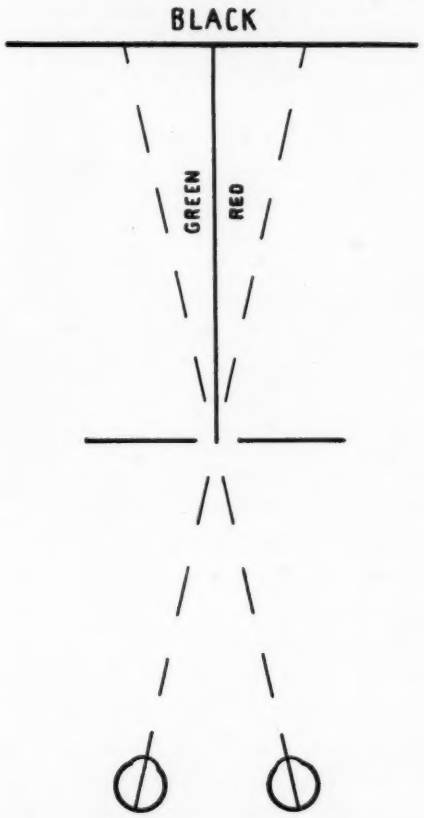

Chart 2.—Diagram of "replacement tester," with hole at the crossing point of the eyes.

concerned in the test, there may be observed by a normal person not merely sudden recurring changes of the whole area from black to red and from red to black, but in various parts of the area transitions as if the finest possible mixing of black and red in varying proportions were occurring. Judging by his statements, this sort of replacement also occurred in the squinter, but the phenomenon took place so quickly that it was doubtful that his statements in this respect could be relied on. Unfortunately, no attempts were made to elicit luster at the cross-

ing point. As already stated, other tests failed to show binocular mixture of colors at this point.

Another question that arises is whether or not in the replacement test with the hole at the crossing point binocular fixation is elicited. Obviously, to demonstrate binocular fixation it would be necessary to prove that it was maintained through some range. As a matter of fact, without loss of incomplete replacement the hole could not be moved a sufficient distance forward or backward to indicate any range of binocular fixation. Still another question is whether or not the test causes correspondence of the primary visual axes. If while the squinter was fixing the hole at the crossing point a rod was placed at a distance from the hole on the primary visual axis of the usually squinting eye, the rod did not appear in line with the hole even when removed from view of the other eye by means of a partition. When another rod was placed in the primary visual axis of the nonsquinting eye, two rods were clearly seen, with or without the partition. The rod before the nonsquinting eye appeared in line with the hole, while the other rod did not appear in line with the hole but was seen in the same position in which it appeared when the squinting eye was occluded. Hence it was evident that correspondence of the primary visual axes did not exist during the replacement test.

The fact that apparently normal replacement may occur when a suitable object is at the crossing point suggests, incidentally, that in cases of convergent strabismus the most effective way to develop binocular fixation and binocular stereopsis would be for the squinter frequently to observe a suitable object moved slowly backward and forward in the vicinity of this point.

It is, of course, a familiar fact that in certain cases of established concomitant strabismus binocular fixation occurs or can be elicited at times. In some of these cases anomalous projection has been demonstrated when the eyes were deviated. Bielschowsky [11b] long ago reported cases of this kind. As a matter of fact, as already stated, I have found that anomalous projection always exists in established cases of concomitant strabismus when the eyes are deviated. According to usual conceptions, there is supposed to be "normal correspondence" when there is binocular fixation and "anomalous correspondence" when the eyes are deviated. In most of these cases the strabismus is of the divergent type, owing no doubt to the fact that often in cases of divergent strabismus binocular fixation has long been utilized before the strabismus has become relatively permanent. I have found that in many of the cases of divergent strabismus binocular fixation can be elicited only for near objects, and sometimes then only when excessive accommodation is produced by means of concave lenses. Probably, however, in cases of convergent strabismus anomalous projection and binocular fixa-

tion thus coexist more often than is suspected, especially in cases in which the deviation in distant vision is so slight that the strabismus itself is overlooked or in which a slight deviation in distant vision is recognized but the occurrence of binocular fixation in near vision is overlooked. I have discovered a number of such cases which I had previously not recognized. In most of these cases the patient stated that definite convergent strabismus had existed in childhood. There are also cases in which with corrected hypermetropia the patient has binocular fixation and stereopsis for distant objects but convergent strabismus for the reading distance.

In a considerable number of the cases under consideration I have been able by means of the kinetic test[19] to demonstrate excellent binocular stereopsis during binocular fixation. In some cases, however, evidently because of the unusual conditions required, binocular fixation either could not be obtained at all in the test or was lost as soon as one of the "balls" was moved. No doubt in most, if not all, of these cases binocular stereopsis existed under ordinary conditions when there was binocular fixation and could have been demonstrated if there had been employed a test which I have recently devised for the purpose, and which I shall describe in a subsequent communication.

Until lately I have accepted as a fact the usual assumption that when binocular fixation exists in these cases retinal correspondence is substituted for anomalous projection. Recently, I put this assumption to actual tests in 5 cases, especially suitable owing to the intelligence of the subjects. In 3 cases the strabismus was divergent, and in the others, convergent. To my surprise the tests showed that the assumption was incorrect, in that anomalous projection continued to exist in spite of binocular fixation and in spite of the fact that retinal images projected to the fixation point underwent normal replacement. In 2 of the cases I was even able to demonstrate the perception of binocular luster, and in 1 of these there was also perception of a binocular mixture of red and green as yellow. In each case there was unquestionably demonstrated binocular stereopsis when there was binocular fixation.

Although I have not yet proved it to be an actual fact, it is probable that in such cases peripheral retinal areas exhibit the same phenomena as the two foveas. In other words, in such cases there probably exists a surface which may be termed a replacement surface, similar to a normal horopter. If two retinal images are projected to the same place in this surface, they may undergo normal replacement. If the same two images are projected beyond this surface, they are seen separated

19. Verhoeff, F. H.: A Kinetic Test for Stereoscopic Vision, Arch. Ophth. **15**:833 (May) 1936.

laterally in space, and each is seen without obscuration by the other. It would seem, therefore, that in cases of established concomitant strabismus, whether or not the crossing point is determined by binocular fixation, correspondence of the primary visual axes does not necessarily exist even when the object of chief attention is situated at this point, nor does correspondence of the visual axes of any object situated on the replacement surface probably exist. Moreover, it would seem in such cases that while partial replacement of one retinal image by its contraocular retinal image can occur only when the images occupy certain fixed contraocular retinal areas, it does not necessarily occur when they occupy these areas. Usually, in fact, each image is then completely seen, unobscured by and separated laterally from the other. Further discussion of the intricate questions here involved is reserved for a communication at a later date, when similar and more searching investigations in regard to it have been carried out in a large number of cases.

Whether or not in the absence of binocular fixation the factor of interocular distance contributes to the perception of depth in cases of strabismus is uncertain. In other words, it is uncertain in such cases whether or not in binocular vision retinal images not consciously perceived play any part in determining the apparent localization of their objects. In the case of the squinter the conditions are possibly somewhat analogous to those that exist in the case of animals the visual fields of which overlap and which have conjugate ocular motion but no convergence. Some of these animals, notably the cat, evidently have excellent judgment of distance. If the eyes of the squinter always maintained a fixed positional relation to each other, as they apparently do in the cat, it is evident that for every position of the eyes, that is to say, for every state of conjugate ocular motor innervation, the position in external space of each point in the binocular field could definitely be determined by the positions of its two retinal images. Just as in the case of disparate images in a normal person, one of the images need not be represented in consciousness while aiding in the perception of depth. But, as compared to the cat, an animal that has no definite foveas, a strabismic person has two disadvantages: When he fixes an object situated, as it generally is, beyond the crossing point, one of the images, since it is further from the fovea, is much more indefinitely represented in the brain than the other, and when the object is placed at different distances the positional relation of the eyes changes, owing to the persistence of the function of convergence. In the case of the cat as well as in that of the squinter, therefore, binocular criteria of depth are available. In the case of a convergent squinter, the nearer objects are to the crossing point, the more definite are the available binocular criteria of relative depth. Hence such criteria presumably

would be most effective for objects within easy reach, that is, within a range within which depth perception is most valuable. But it has never been demonstrated that a squinter when not manifesting binocular fixation ever under any conditions actually makes use of his available binocular criteria of depth. The various tests for stereopsis that I have described elsewhere, including especially the "kinetic test," [19] have failed to demonstrate binocular stereopsis in any case of strabismus during the absence of binocular fixation. Such tests, however, require the use of an instrument such as the stereoscope, and it is possible, in fact probable, that this prevents the acceptance of binocular criteria of depth when binocular fixation is absent. Bielschowsky [11b] found exceptionally with the falling ball test that squinters gave a definitely higher percentage of correct answers when both eyes were open than when the squinting eye was occluded. But a slight increase in the percentage of correct answers does not indicate accuracy of stereopsis commensurate with the binocular criteria. Furthermore, it is not certain that the improvement in depth perception indicated by the falling ball test was due to binocular stereopsis. Several other possible explanations of the results were not excluded, especially the explanation that images within the macula of the squinting eye are localized more accurately in space than are images outside the macula of the fixing eye.

The fact, demonstrated by me in many cases, that all objects appear to be in the same positions whether seen with the fixing eye alone or with both eyes or with the not consciously perceived images excluded by screens seems to prove that the anomalous projection is substantially correct without the aid of these images. However, before the possibility can be dismissed that these images increase the precision of the projection for objects situated within easy reach of the hands, particularly in cases of convergent strabismus, more decisive tests must be employed. The fact that the brain generally makes use of all available criteria makes this possibility almost a probability. With reservations based on this possibility, it would seem that in cases of anomalous projection determinations of the apparent positions of objects are primarily made separately for each eye, by correlation of the conjugate ocular motor mechanism with retinal position and other monocular sensory criteria, and that the separate determinations are then secondarily correlated with respect to the point of view of the fixing eye.

Retinal correspondence, including its remarkable precision, is no doubt primarily dependent on the inheritance of certain sensory factors that are largely if not wholly anatomic. The fact that concomitant strabismus is so often definitely hereditary and the character of the visual phenomena associated with it suggest that it may represent a hereditary reversion to a more primitive type of sensory relation. But,

on the other hand, it is possible that anomalous projection is acquired entirely by experience and that the hereditary factors primarily have to do only with the ocular motor mechanism, particularly with that concerned in convergence, or with the correlation of the motor with the sensory mechanism. In favor of this view is the fact that anomalous projection develops in the many cases in which the strabismus is almost certainly due to excessive accommodation resulting from uncorrected hypermetropia. However this may be, it is clear that at least the accuracy of anomalous projection is determined by experience. This fact is well shown in a case recently observed by me. The patient had marked convergent strabismus with good vision in each eye at an early age and was operated on with only partial success. At the age of 41 tenotomy had been performed. The tendon had not adhered to the globe, and divergent strabismus gradually resulted. Although the patient at the age of 53 had binocular fixation for some positions, when his eyes were divergent he had anomalous projection that was substantially correct. The tenotomized tendon was then advanced to about its original position. Convergent strabismus resulted, and anomalous projection developed or was resumed, again substantially correct, entirely different from that existing when the eyes were divergent.

Satisfying explanations of the phenomena of normal and abnormal vision will remain impossible until essential details concerning the correlations of the nervous mechanisms of the brain in general, including particularly the correlations that especially have to do with visual perception and ocular motility, are available. At present, such details are almost if not entirely lacking.

SUMMARY AND CONCLUSIONS

Precise definitions of corresponding visual axes and of corresponding retinal points are given, based on a method by which such axes and points can be determined. Corresponding visual axes are defined as any two visual axes that as visualized from their respective eyes with the aid of suitable objects appear to coincide. The imaginary line in which they appear to coincide is termed a binocular visual axis. Corresponding retinal points are defined as any two points that are the retinal optical terminals of a pair of corresponding visual axes. The term "retinal correspondence" is synonymous with "normal type of binocular projection."

In most if not all cases of concomitant strabismus, when the eyes are deviated no corresponding visual axes, and hence no corresponding retinal points, can be demonstrated. Anomalous projection is therefore defined as a type of binocular projection in which there are no corresponding visual axes. Associated with it, there can be said to be quasiretinal correspondence. Hitherto it has mistakenly been regarded as unusual, and visual phenomena peculiar to it have been misinterpreted.

During binocular vision in cases of anomalous projection, the retinal image of any object seen usually reaches consciousness only from the eye from which this particular object could be the more distinctly seen in monocular vision without change in fixation. The apparent absolute positions of all images that reach consciousness from the squinting eye are determined by the monocular projection of this eye, possibly assisted by the effects of not consciously perceived images, while their apparent relative positions are judged from the point of view of the fixing eye. The squinter reacts as if, and will usually state that, all objects in the binocular field are seen from the fixing eye alone.

In cases of anomalous projection without amblyopia, two images, one on each fovea, are projected under certain conditions to the same place, the crossing point of the primary visual axes, and under other conditions to two different places separated laterally in space. When the squinter sees the two images as if in different places, he believes that he sees them simultaneously and each completely, and there is no evidence that he does not actually so see them.

The cover test, commonly used for demonstrating heterophoria, affords a simple but conclusive method for demonstrating anomalous projection in cases of strabismus in which the deviation is not unusually slight. Various other tests, including the after-image test, are briefly discussed, and it is pointed out that results obtained by their use may be misleading in certain respects.

The total amount of "suppression" within the binocular field is almost if not exactly the same in the case of the squinter as it is in the case of a normal person. In both instances it explains why in binocular vision all objects are seen singly and with about the same value they appear to have when each is seen only from the eye from which it can be the more distinctly seen. The "suppression" of the squinter, however, differs fundamentally from the "suppression" (replacement) of a normal person and hence may be termed quasireplacement. Under certain abnormal conditions there probably occurs, operating at a lower level, a still different process, to which the term subconscious visual suppression can be appropriately applied. It is more probable that the amblyopia resulting from strabismus is due to this process than to replacement, a normal process.

In almost all cases of convergent strabismus, when the visual acuity is good in each eye, replacement, apparently identical with normal incomplete replacement, can be demonstrated when a suitable object is at the crossing point of the primary visual axes. Presumably the most effective way to develop binocular fixation in a case of convergent strabismus would be for the squinter frequently to observe a suitable object moved slowly forward and backward in the vicinity of the crossing point.

Diplopia is defined as consisting of two types, disparate diplopia and corresponding diplopia.

The distinction between alternating and nonalternating strabismus is of much less importance than commonly supposed. Usually when neither eye is so amblyopic that it is incapable of central fixation, a squinter can in a few moments be taught to alternate at command.

The squinting eye, even in cases of amblyopia, plays an important part in binocular vision and provides certain advantages not possessed by normal persons. It is probable that these advantages often offset the lack of delicate binocular stereopsis.

The vision of squinters is compared to that of animals the visual fields of which overlap and which have conjugate ocular motion but no convergence.

Retinal correspondence, including its precision, is primarily dependent on hereditary sensory factors alone. Whether anomalous projection represents a hereditary reversion to a more primitive type of sensory relation or is acquired entirely by experience remains to be determined.

DISCUSSION

DR. RALPH I. LLOYD: It is not possible to explain a paper of this kind from the platform. I have never been able to understand anything of this involved nature except by sitting down and reading the paper carefully, going over some parts again and again, with illustrations appropriate to its special features constantly before me.

Dr. Verhoeff has given names and titles to various syndromes and tests, and despite the fact that many chosen may be better than those now in use, the introduction of these names without previous explanation complicates the situation. Dr. Verhoeff seems to think that there is no satisfactory definition of fusion, but one can begin by saying that this is a combination of two retinal images of two dimensions each into a single image of three dimensions. As this process takes place in the brain, one cannot study it directly as one would like to, but the demonstration by Henschen of the anatomic arrangement of the visual cortex does give some help toward a better understanding. According to this, studies of the arrangement of the cells in the visual cortex show there are three layers of nerve cells in Gennari's stripe, considered as the ultimate end organs of vision. These may be likened to a sandwich, with the bread representing a superficial and a deep layer of nerve cells, each layer being connected with one layer of the two-layered binocular field of vision. The meat placed between the other two layers is considered as the final organ of vision, wherein an impression registered on the superficial layer and another registered on the deep layer of nerve cells are combined by cells in the intermediate layer. Any process altering the worth of an impression registered on one layer has a decided effect on the resulting mental combination. The best illustration of the effect of altering the image of one eye only is the Pulfrich stereophenomenon. A pendulum is arranged to swing from side to side, with the suspension point and all other aids to localization by the patient occluded. If a smoked glass is placed before

the left eye, the pendulum seems to swing in an oval orbit, moving toward the observer and in front of its normal line of motion as it passes from right to left. On the return trip, that is, from left to right, its path is apparently behind the normal plane and just as much as it was in front in the first half of its swing. If the smoked glass is made heavier and heavier, there will come a point at which the combination of the two images is apparently no longer possible, and the pendulum again swings in the normal plane; but it will now be found that the poorer image is suppressed and that the patient is using but one eye. It is argued, and with good reason from my point of view, that a similar process takes place in cases of squint. The image of the poorer eye is no longer combinable with the image of the good eye, and the visual axis of the poorer eye is swung out of line to permit suppression of the poorer image. When one image is different from the other, as in the Pulfrich test, the image of the eye with the smoked glass before it is weaker than the other and registers a little later than the other, creating a conflict in the mental process of combining these two images of two dimensions each into a single image of three dimensions. As the resulting image must be projected to a place common to each of the two visual axes, the binocular image of the pendulum appears to move nearer to the observer when the darker image belongs to the left eye and the pendulum is swinging to the left. This point common to both visual axes is nearer to the observer than the pendulum as it swings from right to left, but is behind the path of the pendulum when it is on the return trip, from left to right.

Dr. Verhoeff's observations of the effect of an image placed along the visual axis of the squinting eye while the good eye is fixing and the variations of this conform to what is to be expected under the conditions. That suppression of the image of the poorer eye affects only the macula has long been accepted, and the last function the macula loses, irrespective of the position of its visual axis and irrespective of the habit of suppression or lowered visual acuity, is the imperative impulse to fusion of images, impressed on the macula. If the poorer eye squints, as it must do to eliminate the unpleasant subconscious conflict following the effort to combine two unlike images, an object placed so that its image will fall on the squinting macula in the new position will instantly awaken efforts to get the two images to fuse. As the disparity of the macular functions is often too great to allow this consummation, after more or less diplopia a readjustment of the position of the squinting eye allows the original state of suppression of the macular image of the poorer eye to recur, and a comfortable use of the eyes is possible.

Dr. LeGrand H. Hardy: Not having read Dr. Verhoeff's paper, my knowledge of what he believes is limited to what he has said here. I failed to comprehend the significance or relevance of many of his statements, but from the material I did gather I should be forced to draw a set of conclusions differing from his. On the other hand, he has made several statments which I believe not only to be true but to be significant and not widely known. The facility with which a monocular squinter can be taught to alternate is an example. The significant differences in the meaning of words, such as "straight" and "crooked," and the different state of kinesthetic knowledge in the

squinter are less well known examples. The close relation of alternating squint to the monocular type has been accepted only in the past few years.

Dr. Verhoeff has so strongly stressed the superiority and advantage of the strabismic state that one could easily believe that he considers it to be a desideratum.

I draw the following conclusions from his discussion: that he performed the experiments he has outlined here with a few intellectually superior and cooperative patients; that he has not done much clinical orthoptics; that he has not used the synoptophore (or one of the other major amblyoscopes) much as a therapeutic instrument, and that he is not justified on the basis of the material presented in categorically condemning orthoptics as a part of ophthalmologic practice.

He is justifiably derisive toward much that has been published on orthoptics. Nevertheless, sufficient reliable work has been done by trustworthy observers to invalidate a blanket pronouncement, and I should consider it a disservice to ophthalmology should Dr. Verhoeff seek to dissuade any intelligent and earnest ophthalmologist from making attempts to aid his heterophoric and heterotropic patients by means of orthoptic efforts.

DR. JOSEPH I. PASCAL: I want to ask Dr. Verhoeff if he ever found actual fusion of the images at the crossing point. That is, if the images are superposible and fusible, are they not fused at that point? In my experience that has happened. Another point I want to raise is whether this anomalous projection which Dr. Verhoeff has shown in the deviating eye as being projected to the left, according to the direction of the fixing eye, is not similar to what is present normally. It may be a midline, a bivisual line as Duane calls it, or it may be the visual axis of the dominant eye which serves as the base line for the projection of images in the visual field. In this case, the fixing eye being extremely dominant, the image that falls on the other eye is projected according to the normal manner, with the visual axis of the dominant eye as the base line of projection.

DR. F. H. VERHOEFF: At the crossing point I have demonstrated replacement similar to that which occurs in the normal person. No doubt Dr. Pascal would call this fusion. In cases of anomalous projection there are no binocular visual axes; hence the fixing eye is not a dominant eye in the same way that one eye may be dominant in a normal person. Moreover, since objects are projected with reference to the point of view of the fixing eye, in cases of alternating squint it is not always the same eye that could be regarded as dominant in any sense.

DR. JOSEPH I. PASCAL: Normally, when one looks at a point, that is, fixes an object, all the other objects in space are projected with one line acting as a single reference line.

DR. F. H. VERHOEFF: In the case of persons with normal binocular vision, all objects seen by the right eye on a visual axis of the right eye and all objects seen by the left eye on the corresponding visual axis are projected during binocular vision along a single axis, a binocular axis. In the case of squinters with anomalous projection, this is not true, for there are no corresponding axes.

DR. JOSEPH I. PASCAL: They have the monocular axis.

DR. F. H. VERHOEFF: (Diagrams drawn on the blackboard were used by Dr. Verhoeff to explain various points considered in his paper.) In regard to Dr. Lloyd's remarks, I may say that I am familiar with the work of Henschen to which he referred. Many years ago I brought forward a theory of normal binocular vision which accords with Henschen's anatomic observations, but I have not yet been able to explain anomalous projection from an anatomic point of view. I do not agree with Dr. Lloyd that the Pulfrich phenomenon is of importance in explaining binocular stereopsis. The Pulfrich phenomenon is simply due to delayed perception of one of the retinal images of the pendulum, so that there is disparateness of images in the brain. The phenomenon throws no more light on how disparateness produces the effect of depth than do ordinary stereoscopic diagrams. Dr. Pascal asks about fusion at the crossing point. I should like him to define what he means by fusion.

DR. JOSEPH I. PASCAL: I mean superposition of the images; if they are fusible, they fuse. Take an F and an L, and see if they fuse as an E.

DR. F. H. VERHOEFF: If Dr. Pascal calls that fusion, then I am sure that he would say that in cases of anomalous projection my replacement tester shows perfect fusion at the crossing point. I have been able to demonstrate the perception of binocular luster here only when the crossing point was determined by binocular fixation. No distinction is commonly made between binocular fixation and fusion. Travers in his recent monograph does not once use the term binocular fixation, although it is evident that he often means this when he speaks of fusion. For the seeing of two corresponding images as one image I have suggested the term unification. For this phenomenon and for replacement in general I have given an explanation in my paper on "A New Theory of Binocular Vision." [16]

Dr. Hardy spoke about the horopter. In order to have a horopter there must be corresponding retinal points. Patients with anomalous projection do not have a horopter because they have no retinal correspondence.

CANCER OF THE EYELIDS

I. BASAL CELL AND MIXED BASAL CELL AND SQUAMOUS CELL EPITHELIOMA

HENRY L. BIRGE, M.D.
Fellow in Ophthalmology, the Mayo Foundation.
ROCHESTER, MINN.*

Recently I [1] studied the records of 464 cases of cutaneous cancer which arose from the eyelids, from the conjunctiva or from both. Of the carcinomas in this series, 230 were examined and graded histologically; others, for one or another reason, were not. About 60 per cent of the 230 growths, actually 139 of them, were basal cell epitheliomas, and approximately 14 per cent, or 32 of them, were mixed basal cell and squamous cell epitheliomas. This paper is primarily concerned with these two groups, composed respectively of 139 and of 32 tumors.

ETIOLOGY

Whereas the majority of the pure basal cell epitheliomas occurred in persons in the sixth decade of life, the majority of the mixed cell epitheliomas occurred in those in the fifth decade. Men were affected in 61.1 per cent of the cases of basal cell epithelioma and in 65.6 per cent of the cases of mixed basal cell and squamous cell epithelioma.

The etiology of all types of epithelial tumors is related to some extent to trauma and to chronic irritation. In this series, 29.5 per cent of the basal cell epitheliomas were said to be definitely related to these factors. They included mechanical injury from eyeglasses, chronic blepharitis, injury due to squeezing of blackheads or of pimples and the presence of warts, cysts or chalazions which did not heal properly. Of the mixed cell epitheliomas, 31.2 per cent were associated with a history of chronic irritation of some type.

TREATMENT

In 19 of this group of 139 cases of basal cell epithelioma, the most radical type of treatment was resorted to, that is, exenteration of the contents of the orbit. In 9 other cases it was necessary to enucleate

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* The author is now residing in Hartford, Conn.

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1. Birge, H. L.: Epithelioma of Eyelids and Conjunctiva, unpublished thesis.

the globe. In many of these cases, in addition, varying doses of radium were given. Treatment in the remainder of the cases consisted of excision, including diathermy and cauterization, or of a combination of operation and irradiation.[2] The patients who received only irradiation are not considered here but will be dealt with as a separate group.

In this series, exenteration was performed on 20.7 per cent of the patients with mixed cell epithelioma and on only 14.9 per cent of those with pure basal cell epithelioma. This difference in treatment may be in favor of the prognosis of the mixed type of tumor, the more radical method causing a lower gross mortality. If such is the case, the lower malignancy of the mixed basal cell and squamous cell epithelioma is not as great as it appears.

TABLE 1.—*Results of Follow-Up Study of One Hundred and Twenty-Seven Patients with Basal Cell Epithelioma*

Situation of Growth	Total No. of Patients	No. of Patients Traced	Exenteration		Enucleation		Blind in Affected Eye		Died of Carcinoma	
			No. of Patients	Percentage	No. of Patients	Percentage	No. of Patients	Percentage	No. of Patients	Percentage
Lower lid.....	76	69	10	14.5	5	7.2	18	26.0	7	10.1
Upper lid.....	14	10	2	20.0	0	0	2	20.0	2	20.0
Inner canthus.....	37	36	6	16.6	3	8.3	11	30.6	5	13.9
Outer canthus....	12	12	1	8.3	1	8.3	2	16.6	0	0
Entire group....	139	127	19	14.9	9	7.0	33	26.0	14	11.0

RESULTS

Of the 139 patients with basal cell epithelioma, contact was maintained with 127 until 1936. In some cases this represented a follow-up study of more than fifteen years' duration. Eighty-two of the patients were living, 31 had died of causes other than epithelioma and 14 had died from the effects of the epithelioma. This represents a gross mortality of 11 per cent (table 1).

Why should a comparatively benign epithelial tumor situated where it is constantly open to view by the patient and by all who associate with him have a mortality of 11 per cent over a period of fifteen years? I do not believe the fault lies largely with the medical profession. Most of the fatalities are owing to neglect on the part of the patient. Pain is not an early symptom of these lesions. Only 20 per cent of this entire series of 464 patients sought adequate treatment during the first year.

Blindness occurred in 25.9 per cent of the cases of basal cell epithelioma of the eyelids. Basal cell epithelioma did not seem to be as

2. Benedict, W. L., and Knight-Asbury, Mary: Treatment of Malignant Lesions of the Eyelids, New York State J. Med. **29**:675-677 (June 1) 1929.

malignant under the forms of treatment used in this series of cases as was reported in general by Broders and MacCarty [3] in 1916. At that time the general mortality from basal cell epithelioma was 35 per cent.

Basal cell epitheliomas situated in different places on the eyelids were attended by different degrees of mortality. The upper eyelid and the area of skin near the inner canthus were the situations associated with the greatest mortality. Lesions near the inner canthus and those of the lower lid were associated most frequently with blindness. Mixed basal cell and squamous cell epithelioma caused death only when situated near the inner canthus. The incidence of blindness was also highest when the mixed cell type of tumor occurred near the inner canthi.

The mixed cell type of epithelioma was attended by a gross mortality of only 6.8 per cent (table 2). It presented nearly as great a hazard to eyesight, however, since in nearly 25 per cent of the 32 cases blindness in the affected eye had occurred by 1936.

TABLE 2.—*Results of Follow-Up Study of Twenty-Nine Patients with Basal Cell and Squamous Cell Epithelioma*

Situation of Growth	Total No. of Patients	No. of Patients Traced	Exenteration		Enucleation		Blind in Affected Eye		Died of Carcinoma	
			No. of Patients	Percentage	No. of Patients	Percentage	No. of Patients	Percentage	No. of Patients	Percentage
Lower lid.....	14	13	2	15.4	0	0	2	15.4	0	0
Upper lid.....	5	4	1	25.0	0	0	1	25.0	0	0
Inner canthus.....	9	8	1	12.5	0	0	3	37.5	2	25.0
Outer canthus.....	4	4	2	50.0	0	0	1	25.0	0	0
Entire series.....	32	29	6	20.7	0	0	7	24.1	2	6.8

Basal cell epithelioma is only one type of epithelioma found near the eye, and for a better conception of the importance of this lesion a comparison of its course should be made with that of other types of epithelioma (table 3).

Comparison of the percentages of patients with the various types of epithelioma living at the end of three years shows that there is a difference of only 7 or 8 per cent in the behavior of all types of epithelioma early in their course. As time passes, however, certain types of epithelioma definitely become more malignant. This variability in malignancy according to pathologic grading will be shown more emphatically when squamous cell epithelioma is considered. In table 3 it is seen that basal cell epithelioma is more benign than is squamous cell epithelioma. This is only true in part. The basal cell tumor is more benign than is the entire variety of squamous cell tumors, but when basal cell lesions are compared with the individual grades of squamous

3. Broders, A. C., and MacCarty, W. C.: Melano-Epithelioma, Surg., Gynec. & Obst. **23**:28-32 (July) 1916.

TABLE 3.—*Results of Follow-Up Study of Entire Series of Patients with Epithelioma*

Group	Lived Three or More Years After Operation				Lived Five or More Years After Operation				Lived Ten or More Years After Operation				Lived Fifteen or More Years After Operation			
	Number of Patients Operated On*	Number of Patients Traced	Number of Patients	Percentage of Traced Patients	Number of Patients Operated On*	Number of Patients Traced	Number of Patients	Percentage of Traced Patients	Number of Patients Operated On*	Number of Patients Traced	Number of Patients	Percentage of Traced Patients	Number of Patients Operated On*	Number of Patients Traced	Number of Patients	Percentage of Traced Patients
Basal cell epithelioma.....	118	95	87	91.6	108	88	74	84.1	81	64	38	59.4	39	39	18	46.1
Basal cell and squamous cell epithelioma...	18	16	16	100.0	13	11	11	100.0	8	6	5	83.3	4	4	3	75.0
Squamous cell epithelioma...	52	42	35	83.3	42	34	21	61.8	22	17	5	29.4	9	5	1	20.0

* The three year group comprises patients operated on three or more years prior to the time of inquiry; the five year group comprises those operated on five or more years prior to the time of inquiry; the ten year group comprises those operated on ten or more years prior to the time of inquiry, and the fifteen year group comprises those operated on fifteen or more years prior to the time of inquiry.

cell lesions, basal cell epithelioma is found to be more malignant than are certain grades of squamous cell epithelioma. This is well shown in figure 1.

COMMENT

Cutaneous cancer comprises approximately 12 per cent of all epitheliomas.[4] Cancer involving the eyelid comprises from 3 to 5 per cent of all epitheliomas.[5] The term "cutaneous cancer" is not limited in meaning to any one type of tumor, and consequently definite help in prognosis is not derived from use of this loose term in diagnosis. On the basis of a pathologic diagnosis a more definite prognosis can be made.

Epitheliomas near the eyelid and conjunctiva show definite variation in ability to blind and to cause death according to their pathologic types. It is important for the clinician to know whether an epithelioma is of

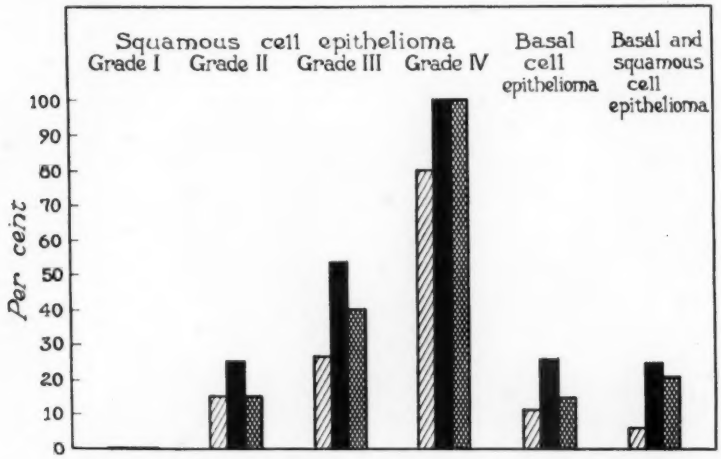

Fig. 1.—Mortality and blindness produced by various grades of epithelioma found about the eye. The area of diagonal lines indicates the number of patients who died of cancer of the eye; the solid area, those who became blind as a result of lesions of the eye, and the area of crossed lines, those who underwent exenteration.

the basal cell type, of the squamous cell type or of a mixture of the two types. The presence of both basal cells and squamous cells in a lesion seems to be important, as viewed in the light of this series, because of the lower mortality that occurred among the patients who had mixed basal cell and squamous cell epitheliomas. The lower mortality attending this type of tumor may be explained on the basis of a greater tendency to differentiation of the individual tumor cells.

4. Broders, A. C.: Squamous-Cell Epithelioma of the Skin, Ann. Surg. **73**: 141-160 (Feb.) 1921.

5. Geschickter, C. F., and Koehler, H. P.: Ectodermal Tumors of the Skin, Am. J. Cancer **23**:804-836 (April) 1935.

The prognosis varies not only with the pathologic type but with other factors, including age, size of the lesion, type of treatment received previously and occupation.[6] Especially important in dealing with the early lesion is its situation on the eyelid. The chief danger associated with any tumor of the eyelid lies not so much in the occurrence of metastasis as in extension of the process into the orbit and into the cranial cavity.

Basal cell epithelioma is the most frequent type of tumor of the eyelid, as it is of the skin in general. Nevertheless, the basal cell epithelioma that involves the eyelid is not a common tumor from the standpoint of the general surgeon or the pathologist. In fact, it does not occur frequently even among tumors of the eyelid. O'Brien and Braley found only 15 carcinomas among 100 consecutive tumors of the eyelids.[7]

The importance of basal cell epithelioma is mistakenly minimized by the conception generally held that basal cell lesions are associated with but a slightly more serious outcome than are benign tumors. To the ophthalmologists, the basal cell lesion of the eyelid becomes important in proportion to its ability to blind or to kill. Basal cell tumors are quite likely to cause blindness of the affected eye, in spite of the use of every known method of treatment or of a combination of treatments. Basal cell epithelioma is, therefore, an important type of tumor, and the ophthalmologist should be familiar with it.

In this series,[1] basal cell epithelioma did not arise primarily from the conjunctiva or from the cornea, as did squamous cell epithelioma. Frequently, however, it involved the conjunctiva and the cornea secondarily.

It has been said that the most satisfactory method of treating basal cell epithelioma is by irradiation. This is not true in every case, although irradiation proved effective in the cases in which it was used in the whole series of 464. The main objection is that when a specimen is not taken for biopsy the pathologic type of the lesion being treated is not known. The danger of irradiation, cataract or other complication damaging sight is small when the dosage is properly given.

In order to save time, which is important in dealing with malignant growths of high grade, epitheliomas should be examined histologically before one decides on a definite course of treatment. If the lesions are small, as they often are about the eyelids, complete excision is preferable to biopsy. If irradiation is used without previous histologic examination, a certain percentage of patients who have lesions which

6. Lane, Laura A.: Symposium on Cancer: An Occupational Study of Cancer of the Eye and Adnexa, Surg., Gynec. & Obst. **64**:458-464 (Feb.) 1937.

7. O'Brien, C. S., and Braley, A. E.: Common Tumors of the Eyelids, J. A. M. A. **107**:933-938 (Sept. 19) 1936.

are radioresistant or of a high grade of malignancy will suffer from delay of surgical treatment. If an epithelioma of the eyelid has extended into the orbit, the chances of cure are appreciably reduced.

REPORT OF CASES

CASE 1.—A woman aged 64 had a growth on the right lower eyelid which had existed for nine months (fig. 2*a*). It was excised, and a plastic wing flap operation was performed. The pathologic diagnosis was basal cell epithelioma. One year later a lesion recurred. This was excised, but the pathologic examination disclosed that only inflammatory tissue was present.

Fig. 2.—Basal cell epithelioma: *a*, early lesion; *b*, and *c*, recurrent lesions, and *d*, neglected lesion.

CASE 2.—A man aged 64 noted gradual development of a tumor near the outer canthus of the right eyelids four years before he came to the clinic. Excision had been performed and a skin graft employed after the tumor had been present for two years. The tumor recurred (fig. 2*b*) and was treated five times with roentgen rays in the city where the patient resided. Treatment by electric needle was given just before the patient came to the clinic. Vision in the right eye was 6/20 and in the left eye 6/30. The epithelioma was excised, and a graft from the thigh was inserted. Radium, 1,037 milligram hours, was applied; the eye was protected with a 2 mm. lead shield. The pathologic diagnosis was basal cell epithelioma.

CASE 3.—A man aged 68 years had noted lumps near the outer canthus of the eyelids for three years. They grew and disappeared but recurred (fig. 2 *c*). A diagnosis of basal cell epithelioma was made, and the patient was advised to have radiation therapy.

CASE 4.—A man aged 62 had a growth on the left lower eyelid for ten months. It began as a small pimple, varied in size and then grew again and became flaky. The lesion had been treated with castor oil, sodium bicarbonate and grease (fig. 2 *d*). There were enlarged lymph nodes in front of the left ear and in the submaxillary region (inflammatory). This lesion proved to be a basal cell epithelioma. Also, there were present two other large basal cell epitheliomas; one was situated on the chin, and the other was situated over the left mastoid prominence. Radium therapy was advised because of the extent and multiplicity of the lesions.

CASE 5.—A woman aged 55 injured her left upper eyelid with the rider of her eyeglasses (fig. 3 *a*), after which a mass developed, which measured 7 by 3 mm.

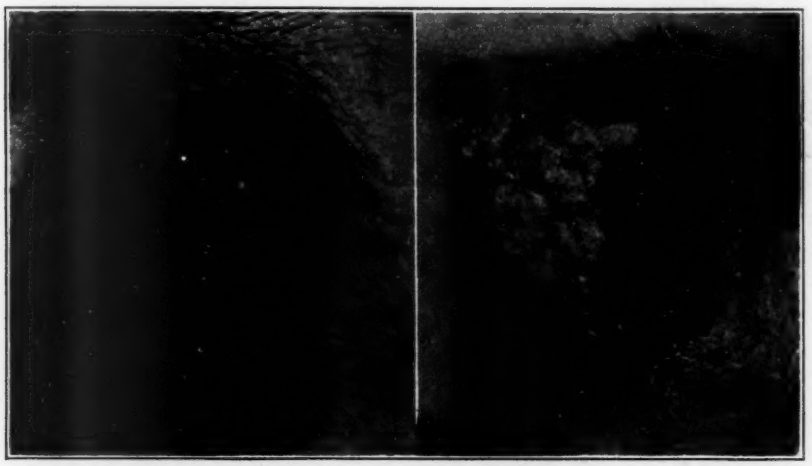

Fig. 3.—Mixed basal cell and squamous cell epithelioma: *a*, early lesion, and *b*, neglected lesion.

It was excised with the diathermic knife, and the pathologic diagnosis was mixed basal cell and squamous cell epithelioma.

CASE 6.—A man aged 61 had a tumor on the left side of the nose where eyeglasses had touched it. The tumor had been present for ten years and had been treated with radium occasionally. One year before he came to the clinic he discontinued radium therapy and took up faith healing. At the time of examination at the clinic the growth measured 4.5 by 4.5 by 2.5 cm. It was red and firm but was not broken down (fig. 3 *b*). The pathologic diagnosis was basal cell and squamous cell epithelioma, grade 3. Exenteration of the contents of the orbit was performed, and he was given 14,000 milligram hours of radium.

SUMMARY AND CONCLUSIONS

In a group of basal cell and of mixed basal cell and squamous cell epitheliomas, the mortality rate of the basal cell epitheliomas of the eyelids was 11 per cent; that of mixed basal cell and squamous cell epitheliomas was 6.8 per cent.

Of the patients who had basal cell epithelioma of the eyelid, 46.1 per cent lived fifteen years or more after they received treatment. Of the patients who had mixed basal cell and squamous cell epithelioma, 75 per cent lived fifteen years or longer after treatment was received.

The basal cell lesion was more malignant than was either the mixed basal cell and squamous cell epithelioma or the lower grades of pure squamous cell epithelioma.

Blindness resulted from basal cell epithelioma in 25.9 per cent of the affected eyes in 127 cases in which a follow-up study was made. Blindness was equally frequent in the group of cases of mixed cell epithelioma.

The mortality and blindness resulting from basal cell epithelioma could be reduced considerably if patients would report earlier for treatment and if they were observed more regularly after treatment had been given, until they were cured. Only 20 per cent of the patients in the entire series of 464 sought adequate treatment in the course of the first year.

Treatment of tumors of the eyelids should be governed by pathologic diagnosis. Basal cell epithelioma was only one type of malignant tumor found on the eyelid. Each variety of tumor differed from others in its ability to cause blindness and death. With utilization of the knowledge concerning the relative malignancy of the different tumors of the eyelid, further refinements of treatment may be accomplished.

SUPERFICIAL PUNCTATE KERATITIS

ITS TREATMENT WITH IODINE SOLUTIONS

ALFRED COWAN, M.D.
AND
THOMAS H. COWAN, M.D.
PHILADELPHIA

The term superficial punctate keratitis may be considered a general morphologic designation for multiple, small, discrete lesions of the cornea which affect only the epithelial and the immediate subepithelial tissues. Excluding those cases in which the condition is obviously due to various chemical irritants, there remain two clinical variants generally seen in the United States. Graves [1] has described these as the subepithelial and the epithelial type. In the former, exemplified by the classic superficial punctate keratitis of Fuchs, the lesions are relatively few in number and centrally located on the cornea, with perhaps some "metastatic" lesions toward the corneal margins. These lesions are usually circular and slightly raised, with crenated edges, and are visible macroscopically. They cause some disturbance of Bowman's membrane or of the underlying stroma. The epithelial type consists of multiple tiny erosions occurring all over the cornea, especially at the margins. Only the epithelium is affected, the underlying tissues remaining intact. There seems to be no general accord on the correlation of these two morphologic pictures with the etiology or the clinical course of the disease. Authors generally agree, however, that the condition is variable, that it may last indefinitely and that it may recur after apparent recovery has taken place. This uncertain course is especially true of the epithelial type.

TREATMENT AND RESULTS

In regard to treatment, most authors voice pessimism on the response of superficial punctate keratitis to various forms of therapy and on the ability of treatment to prevent relapses. Doggart [2] stated that a large number of different remedies have been used but that none

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Read before the Section on Ophthalmology, College of Physicians of Philadelphia, Oct. 21, 1937.

1. Graves, Basil: Diseases of the Cornea, in Berens, C.: The Eye and Its Diseases, Philadelphia, W. B. Saunders Company, 1936, pp. 511-513.

2. Doggart, J. H.: Superficial Punctate Keratitis, Brit. J. Ophth. **17**:65 (Feb.) 1933.

has been found which will hasten the absorption of the corneal opacities, and that the natural course of the disease, lasting months or years, takes place regardless of the form of therapy. Chambers [3] advocated the use of physiologic solution of sodium chloride and considered it equal to any other form of treatment. Lloyd [4] stated that no treatment superior to the customary protection and the use of a local antiseptic has been discovered.

The question as to whether superficial punctate keratitis is really allied to herpetic keratitis is, of course, open to grave question, but the success of iodine therapy in conditions known to be of a herpetic nature prompted us to try equivalent agents in the treatment of superficial punctate keratitis, some forms of which are considered by many clinicians to be herpetic. Iodine has been used by others in the treatment of superficial punctate keratitis. Gifford [5] advocated the cauterization of the individual lesions with tincture of iodine. This method is somewhat inconvenient, especially with the epithelial type, in which the multiplicity and small size of the erosions make the procedure all but impossible. Fradkine [6] used an iodine preparation intravenously in three cases with success.

In our private practice during the past eighteen months we have been using preparations containing iodine in the treatment of superficial punctate keratitis. Our routine is to prescribe for use at home by the patient a 1 per cent solution of potassium iodide, containing 1 or 2 minims (0.06 or 0.12 cc.) of compound solution of iodine U. S. P. to the ounce (29.57 cc.). This is instilled into both eyes (even if the condition is unilateral) three times a day and is continued long after recovery, to prevent recurrences.

For treatment in the office, Pregl solution [7] is employed in the form of conjunctival packs. This solution has been found by Cowan and Jordan [8] to be valuable in the treatment of other corneal diseases, par-

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3. Chambers, E. R.: Keratitis Punctata Superficialis, Brit. M. J. **1**:750-751 (May 2) 1931.

4. Lloyd, R. I.: Herpes and Allied Conditions, Tr. Am. Acad. Ophth. **35**:278, 1930.

5. Gifford, H.: Ocular Therapeutics, ed. 2, Philadelphia, Lea & Febiger, 1937, p. 202.

6. Fradkine, M. J.: Three Cases of Superficial Punctate Keratitis Subepithelialis, Bull. et mém. Soc. franç. d'opht. **45**:135, 1932.

7. Pregl's solution (concentrated) is a complex aqueous solution containing 3 per cent of available iodine in the form of hypoiodite and hypoiodate ions and some free iodine. Most of this is liberated as nascent iodine in the presence of weak acids. It is relatively nonirritating to living tissue.

8. Cowan, A., and Jordan, J. S.: Pregl's Solution in the Treatment of Ocular Conditions, Pennsylvania M. J. **38**:704 (June) 1935.

ticularly when corneal infiltration is present. The technic of application is as follows: A small loose pledget of absorbent cotton is soaked with 0.5 cc. of the fresh solution from an ampule. The lower lid, after anesthetization with butyn, is pulled away from the eyeball while the patient looks up. The pledget, held by a small forceps, is inserted into the lower cul-de-sac, and the patient is instructed to close the eye. The pack is allowed to remain for ten minutes. This treatment is repeated at intervals up to four days, when possible, until the lesions no longer stain. Whether Pregl solution employed in this manner has any greater therapeutic virtue than other iodine solutions, we have not determined. However, in the procedure outlined it causes no discomfort other than a mild burning sensation while the pack is in place. After the pack is removed, considerable conjunctival injection may be noticed, but this soon disappears.

In most of the patients we have treated in this manner we have noted a quick resolution of the lesions and freedom from, or delayed, recurrence. In all of the cases cited, whether the condition was of the type described by Fuchs or of the epithelial type, it was severe, with marked symptoms, pericorneal injection, decreased sensitivity of the cornea and gross corneal involvement, with multiple staining lesions. None of those cases, so frequently seen, in which there are a few staining points on the cornea and minor symptoms is included in the present series. No patient was considered cured until the lesions had entirely disappeared, whether symptoms were present or not.

In only two of our series of twelve cases was the morphologic picture considered to be that described by Fuchs. The staining with fluorescein in these was light and rather diffuse. In one, the lesions disappeared in two weeks, the treatment consisting of one Pregl pack and instillations of the potassium iodide solution. No recurrence had taken place at the end of sixteen months. The patient had been treated unsuccessfully with phenacaine and atropine and had worn a bandage for one month. In the other case, the condition cleared up entirely in two months, with very irregular treatment, including two Pregl packs and intermittent use of drops of potassium iodide. The patient stated that he suffered a mild recurrence after eight months, which subsided quickly under self-medication. We did not see the eye at this time.

In the remaining ten cases, examples of the epithelial type, the morphologic appearance varied from rather granular lesions, visible macroscopically and situated in the center and periphery of the cornea, to multiple tiny spots, invisible even under the slit lamp unless stained. Generally speaking, the condition had been present for long periods, and some of the patients had been unsuccessfully treated by other methods.

In four cases the condition cleared up entirely within four days, the treatment consisting of one Pregl pack and drops of potassium iodide. The disease had been present for periods varying from two weeks to four years. In four other cases recovery occurred in two weeks. Three Pregl packs and drops of potassium iodide were used in each, and the last attack had been of several months' duration. Recurrence had not taken place in any of these cases up to an average of five months.

One patient, subject to continual irritation with aggravation of symptoms every other month, recovered in one month, and was free from symptoms for about thirteen months, after which an acute recurrence took place. Drops of potassium iodide only were used by this patient for two weeks. One other patient experienced subjective comfort after the use of one Pregl pack, but a few staining lesions were present after one month of treatment, consisting of five packs and the continuous use of drops of potassium iodide. Probably this patient will suffer a recurrence.

Generally, therefore, superficial keratitis seemed to respond well to treatment with iodine. It is our impression that best results were obtained when the disease was not of too long standing. Our most difficult cases seemed to be those in which the lesions were very small and numerous. Recurrence or exacerbations occur if treatment is stopped before all staining lesions have disappeared. In a few cases in which the symptoms were severe, mydriatics were used. No bandage was applied. In some instances, in which a residual conjunctivitis remained, the lids were touched with 1 per cent solution of silver nitrate with considerable benefit. No foci of infection were removed.

In conclusion we should like to state that we realize fully the purely empiric nature of this therapy. Results have been judged without rigid control, and all of our patients have not been followed for long periods. Nevertheless, the results we have obtained so far, in a previously baffling condition, prompt us to offer a harmless procedure in the hope that it will prove equally successful in other hands.

DISCUSSION

DR. WILLIAM ZENTMAYER: I have been using for the treatment of this condition an iodine preparation composed of a 6 per cent solution of iodine in a petrolatum base. Recently I used this preparation on a patient who had a herpetic eruption on the face (not herpes zoster), with a denudation of the cornea about 7 mm. in diameter, and after treatment for two days this area was reduced to about 2 mm. The use of this preparation is not at all painful, and treatment can be repeated daily. I do not believe that there is any better therapy for scleritis than massage with this preparation of iodine.

DR. GEORGE J. DUBLIN: I should like to report a case in which I used the treatment advocated here. A patient with herpetic ulcer had

been under the usual method of treatment for approximately eleven months without improvement. I tried subconjunctival injections of Pregl's solution, but without success. In desperation I had Dr. Alfred Cowan see the patient. He suggested trying the instillation of potassium iodide and the use of Pregl's solution by means of a pack. The potassium iodide was used in 1 per cent strength and instilled into the cul-de-sac three times a day. The pack was used every other day for six treatments. At no time did the cornea fail to show some stained areas prior to the new treatment. After the six treatments there were no stained areas for three successive visits, which covered a period of two weeks. The condition of the eye improved, and the patient was discharged as cured. I attribute the cure to this form of treatment.

AVERTIN ANESTHESIA FOR OPHTHALMIC OPERATIONS

JOSEPH LAVAL, M.D.
NEW YORK

There is no doubt that a local anesthetic is sufficient for the great majority of operations on the eye. Properly used it is highly efficient. However, there are certain patients for whom general anesthesia is not only better but definitely indicated. Very young children cannot be controlled without the use of a general anesthetic. Nervous, apprehensive patients, who in their anxiety to help often ruin a perfectly executed operation for cataract or some other delicate intraocular manipulation, should be given a general anesthetic. Operations on congested, painful globes, such as those from acute glaucoma, chronic congestive glaucoma and secondary glaucoma in acutely inflamed eyes, evisceration of acutely inflamed eyes and restoration of a socket are more easily performed with general anesthesia no matter how well a local anesthetic may be administered. Extensive orbital operations are not comfortably performed with local anesthesia, and in certain cases removal of the lacrimal sac is far from painless when a local anesthetic is used. Certainly no ophthalmic surgeon will deny that some of his patients must have a general anesthetic. Both Wilmer [1] and Davis,[2] in the United States, and Morgan and Lees,[3] in England, were enthusiastic about the use of avertin.

Avertin was originally described by the chemists Willstaetter and Duisberg [4] in 1923 and has been used on the Continent since 1927, since its introduction into therapeutics by the pharmacologist Eicholtz, of Freiberg. Wessley [5] first described its used for operations on the eye in 1929. It is a crystalline white substance which is soluble in water at 40 C. up to a 3.5 per cent solution. It is a tribromethyl alcohol and is called tribromethanol in the literature of distributors in the United States. A 2.5 per cent solution is freshly prepared at body tempera-

1. Wilmer, W. H.: Avertin as an Anesthetic in Ophthalmic Surgery, Tr. Am. Ophth. Soc. **28**:42-53, 1930.

2. Davis, F. A.: Tribromethanol (Tribromethyl-Alcohol, Avertin) as an Anesthetic in Eye Surgery, Tr. Am. Ophth. Soc. **29**:47-74, 1931.

3. Morgan, O. G., and Lees, J. M.: Rectal Narcosis in Ophthalmic Surgery, Brit. J. Ophth. **14**:577-582 (Nov.) 1930.

4. Willstaetter, R., and Duisberg, W.: Zur Kenntnis des Trichlor-und-Tribrom-äthylalkohols, Ber. d. deutsch. chem. Gesellsch. **56**:2283-2286, 1923.

5. Wessley, K.: Die Bedeutung der Avertin-Narkose fur die Augenheilkunde, Arch. f. Augenh. **100**:556, 1929.

ture and is never heated to above 40 or 45 C. The solution is neutral to congo red, but when heated to the point of hydrolysis it will turn congo red blue. Accordingly, before the avertin solution is used, it should be tested with congo red to see that it definitely turns orange-red in color. A dose of from 0.08 to 0.1 Gm. is given per kilogram of body weight. For obese, cachectic or debilitated patients the dose is slightly less, and for children and for robust adults between 20 and 35 years of age it is slightly higher. Women are slightly more sensitive to avertin than men. For animals the lethal dose is 1.75 times the dose necessary to produce complete anesthesia. Most of the avertin is eliminated through the urine in six hours, but traces may be found even two days later.

The patient is admitted to the hospital preferably the night before the operation, but this is not essential. A mild hypnotic, such as allylisopropylbarbituric acid with aminopyrine, phenobarbital or sodium amytal, is administered that evening. The next morning an enema is given. Two hours before the operation 1 grain (0.06 Gm.) of codeine sulfate and 3 grains (0.19 Gm.) of sodium amytal are given, or else one hour before the operation 1/6 grain (0.01 Gm.) of morphine sulfate and 1/150 grain (0.0004 Gm.) of atropine sulfate are given hypodermically. Some anesthetists, however, are strongly opposed to using morphine at all. One-half hour before the operation avertin is given by rectum. When the patient is on the operating table the usual local anesthetics are instilled into the eye the same as if local anesthesia were to be used for the operation; this includes the injection of procaine hydrochloride for control of the lids during cataract extraction, but retrobulbar injection of procaine hydrochloride is not necessary in any case. If this local reenforcement is carried out, reenforcement with gas or ether will seldom be needed, and if it is necessary the amount will be almost negligible.

Avertin has many advantages over ether. It is administered in the patient's room, and the patient is wheeled into the operating room under the influence of the anesthetic. The effect is that of a normal sleep, so that there is no stage of excitement and the patient gradually loses consciousness in from two to fifteen minutes. Surgical anesthesia is obtained in thirty minutes; it lasts for two hours and is followed by sleep and analgesia for four hours. Amnesia is complete, and the patient has no recollection of receiving the anesthetic or of the operation. This is especially advantageous with children. The patient awakens from the sleep refreshed.

There are no cardiac or pulmonary complications to be feared. There is seldom any vomiting, and if it does occur it is slight; if morphine is not used, the incidence of vomiting is negligible. Moderate excitement is rarely seen after the period of anesthesia, but in cases in which

it does occur it may be due to alcoholism. There is no apparatus near the nose and throat, as is necessary when ether is given; so there is no fear of contamination from that source. It is remarkable that when avertin is used bleeding is diminished and is definitely less than when a local anesthetic alone is used. Certainly there is much less bleeding than when ether is used. The blood pressure is moderately lowered by avertin, and the subsequent rise is never higher than to the level present before the operation. Intraocular tension is moderately decreased, and in cases of glaucoma this is a definite advantage. During cataract extraction the cornea often becomes concave after the section is made and this gives the surgeon a feeling of security.

There are few contraindications to the use of avertin. It should not be used for patients with hepatic or renal disease. It is excreted through the kidneys, and it is possible that diseased kidneys may be injured. Of course, patients with colitis or disease of the rectum should not be given avertin. Respiratory complications are rarely seen, and in cases in which they do occur inhalations of carbon dioxide, the intravenous injection of dextrose, injections of camphor and caffeine, a cleansing enema or the use of epinephrine hydrochloride will be of benefit. The death rate has been reported as 1 in 10,000.

According to Goldschmidt and Harvey,[6] their "studies indicate that failures and accidents may be justly ascribed to unskilled application of the anesthetic and that by proper indication, proper dosage and proper method of administration of tribromethanol these may be easily avoided and furthermore, that the introduction of this drug as a basal anesthetic marks a new era in modern anesthesia."

At the Mount Sinai Hospital and the Manhattan Eye, Ear and Throat Hospital this anesthetic has been found to be extremely useful and safe for ocular operations and is recommended highly to ophthalmologists.

The following cases will serve briefly to illustrate how avertin can be used with benefit for ophthalmic operations.

CASE 1.—A woman 47 years of age, with a blood pressure of 300 systolic and 140 diastolic, had repeated retinal hemorrhages and incipient cataractous changes. The lenses finally became entirely opaque within a year, and it was decided to perform a preliminary iridectomy on the right eye, using local anesthesia. The patient behaved poorly during this operative procedure, moving the eyes about constantly, moving her head and talking incessantly, even though 1 grain of codeine and 3 grains of sodium amytal had been administered two hours before the operation. For the extraction of the lens eight weeks later, avertin was given as previously outlined. The patient was brought to the operating room in a deep, sound sleep. A mixture of pontocaine hydrochloride and epinephrine hydrochloride was instilled into the eye, and procaine hydrochloride was injected according to

6. Goldschmidt, E. F., and Harvey, S. C.: Rectal Administration of Tribromethanol: Its Use Abroad, Am. J. Surg. **18**:467-477 (Dec.) 1932.

the method of Van Lint for control of the lids. The operation was performed with extreme ease, and all necessary toilet of the wound was leisurely carried out. Irrigation of remnants of the lens was continued until the pupil was black. There was no hurry, no tension or no fear of the patient's "upsetting the apple cart." The patient slept soundly for six hours in her room and awoke entirely refreshed. The next day she had no recollection of the operation.

CASE 2.—A child 7 years old was subjected to recession of the internal rectus muscle and resection of the external rectus muscle of the right eye under ether anesthesia. Sutures of 00 plain catgut were used. Five days after the operation it was noticed that the right eye was divergent and could not be brought beyond the midline. The child had been controlled with great difficulty while induction of the anesthesia was being carried out. After the operation she was plainly upset and intolerant of both nurses and doctors. It was decided to reattach the internal rectus muscle and to use avertin anesthesia reenforced by nitrous oxide and ether. The child fell asleep in her room and was brought to the operating room in a deep sleep. After the operation she slept soundly for eight hours and on awaking did not remember the operation. Her attitude toward the nurses and doctors was friendly, and she volunteered the information that she did not know she had been operated on again. Incidentally, it is of interest to report here that the sutures of 00 plain catgut were almost entirely absorbed within five days after the original operation. For the reattachment, sutures of 000 chromatic catgut were used, and this time there was no slipping of the muscle.

CASE 3.—A man aged 62 had had chronic congestive glaucoma of the left eye for nine months. When he was examined, an operation was advised. He was brought to the operating room under the influence of avertin, and a mixture of pontocaine hydrochloride and epinephrine hydrochloride was instilled into the eye. A trephine operation was performed with complete ease. The patient slept throughout the entire operative procedure. Not once was there any reaction which might indicate that he was experiencing any pain. When the iris prolapsed and was excised there was no wincing. He slept soundly for six hours after the operation and on awaking had to be reassured that the operation had already been performed.

CASE 4.—A man aged 40 had an acute purulent dacryocystitis, which was incised and drained externally. Three weeks later, when healing was complete, the left lacrimal sac was removed, avertin anesthesia being used. A mixture of procaine hydrochloride and epinephrine hydrochloride was injected into the region of the lacrimal sac exactly as if local anesthesia were to be used for the operation. Even though there had been a recent acute inflammation of the sac, the bleeding was minimal, so that the suction apparatus was not needed. There was no evidence of any pain throughout the entire procedure. The patient was allowed to go home two days after the operation.

CASE 5.—A woman aged 72 was admitted to the hospital with hypopyon keratitis in an eye with long-standing absolute glaucoma. Evisceration of the eye was done with the patient under avertin anesthesia, local instillation of pontocaine hydrochloride and ephinephrine hydrochloride plus the subconjunctival injection of a few minims of 4 per cent solution of cocaine hydrocholoride being used for reenforcement. There was no evidence of pain throughout the procedure. The patient slept for ten hours after the operation and was sent home three days later.

Whenever local anesthesia has been contraindicated at the Institute of Ophthalmology of the Presbyterian Hospital avertin has been the

anesthetic of choice for several years. According to information obtained from Dr. John Wheeler, which I am using with his permission, between 35 and 40 patients a month are operated on under avertin anesthesia. It is used for operations on muscles, for plastic operations, for operations for detachment of the retina and for enucleation both in adults and in children over 5 years of age. It is used for younger children only when specially requested by the surgeon. At times, of course, avertin must be reenforced with nitrous oxide and a minimal amount of ether.

At the Herman Knapp Memorial Eye Hospital and at the Brooklyn Eye and Ear Hospital it has been used only in isolated cases. At the Mount Sinai Hospital and the Manhattan Eye, Ear and Throat Hospital this anesthetic has been extremely useful for operations on the eye and is used in selected cases, sometimes being reenforced with nitrous oxide and an extremely small amount of ether.

NET AVERAGE YEARLY CHANGES IN REFRACTION OF ATROPINIZED EYES FROM BIRTH TO BEYOND MIDDLE LIFE

E. V. L. BROWN, M.D.
CHICAGO

Most studies of the changes in the refraction of the eye lack both accuracy and mass of observation. There are two notable exceptions. Steiger [1] in 1913 studied hundreds of Swiss school children between 6 and 11 years of age and developed therefrom his biologic theory of inheritance of states of refraction and the changes which take place in the eyes of growing children. The refraction was determined by the "manifest" method, without cycloplegia, and his conclusions are open to criticism on this score. The second study was made by Kempf, Jarman and Collins [2] for the United States Public Health Service in 1928 on the homatropinized eyes of 1,860 school children, and the results should therefore be more accurate than those of Steiger. A more recent study of the problems connected with defective vision in school children was made on the homatropinized eyes of 2,625 children by twenty-two observers for the Committee of Inquiry of the Great Britain Board of Education.[3] The report contains a comment on the considerable disparity in the work of the individual observers, although they were well trained men.

In all of these studies, however, the refraction of a group of persons of a given age is compared with the refraction of another group of persons a year older or younger, and the difference between the two is looked on as the change which probably takes place between one age and another.

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From the Max Epstein Dispensary and Billings Hospital, School of Medicine, University of Chicago.

1. Steiger, A.: Die Entstehung der sphärischen Refractionen des Auges, Berlin, S. Karger, 1913.

2. Kempf, G. A.; Jarman, B. L., and Collins, S. D.: A Special Study of the Vision of School Children, Pub. Health Rep. 43:1713 (July 6) 1928. Kempf, G. A.; Collins, S. D., and Jarman, B. L.: Refractive Errors in the Eyes of Children as Determined by Retinoscopic Examination with a Cycloplegic, Bulletin 182, Treasury Department, United States Public Health Service, 1929.

3. Defective Vision in School Children, Report of the Committee of Inquiry, Great Britain Board of Education, London, His Majesty's Stationery Office, 1931.

Actually these deductions may be correct or nearly correct, for statisticians state that considerable masses of data minimize moderate deviations in individual data and render deductions relatively reliable. Yet such studies are in the nature of things inaccurate in comparison with data obtained on the same person, studied year after year.

In the present paper, therefore, an attempt is made to meet the requirements both of accuracy and of mass of observation. The paper is concerned solely with the matter of the net average yearly changes in static refraction in atropinized eyes from birth to the end of the fifty-first year. It has nothing to do with particular states of refraction (hyperopia, myopia or astigmatism). At the outset it is frankly stated that the mass of data after about the thirty-fifth year of life is inadequate for safe deductions (few patients submit to a second test with atropine after, say, 35) and that a record of changes between birth and the end of the first year of life is lacking because atropine has not been used a second time in the first year of life. The data between the second and the thirty-fifth year of life inclusive are, however, considerable (8,419 observations).

The claim for greater accuracy is based on the greater exactness of determinations of refraction under atropine than under homatropine or scopolamine or without cycloplegia. In his study Bothman [4] demonstrated beyond question that atropine is a better cycloplegic than homatropine. In cases of hyperopia every sixth meridian showed an increase (decrease of refraction) of 0.75 diopter or more, and in cases of myopia every seventh meridian was decreased (its refraction increased by 0.75 diopter or more). The comparison covered a series of 1,260 eyes.

The present material comprises 8,820 observed and computed changes in the refraction of one or both eyes of 1,203 persons between birth and the end of the fifty-first year. These consisted of 611 patients observed in the clinic and 592 patients from private practice.

METHOD OF OBTAINING AND CALCULATING DATA

Atropine sulfate in 1 per cent solution was used by the patient before each meal and before retiring for three and one-half days for a total of fourteen or fifteen times, depending on whether the test was made in the morning or the afternoon of the fourth day. If the patient missed one dose, the results of retinoscopy and their agreement with the results of the trial case test were usually satisfactory, but when two or more doses were omitted the results of retinoscopy were often found to be "unsatisfactory," and the drug was continued until satisfactory data were obtained. For at least 50 per cent of all patients, a second

4. Bothman, L.: Homatropine and Atropine Cycloplegia: A Comparative Study, Arch. Ophth. **7**:389 (March) 1932.

colleague "checked" the retinoscopic findings. All retinoscopic examinations were done by persons who were at that time teaching and demonstrating retinoscopy in the ophthalmic clinics of either the University of Illinois or the University of Chicago at a time when I was actively in charge of the dispensary work of these institutions.

The presence or absence of astigmatism was taken into account only so far as a given amount of astigmatism contributed to the average of the refraction in the two principal meridians; e. g., if the vertical meridian showed a need of correction of, say, + 1.00 and the horizontal meridian a correction of + 3.00, the refraction was considered, for the purposes of this paper, to be + 2.00, and so listed. Two or more such determinations of the refraction were made at intervals of one or more years for every subject, and the changes for the particular years were noted. In cases in which the first retinoscopic examination was made when the child was, say, between the ages of 6 and 12 months and the next examination was made before the child was 2 years old, the difference between the two was considered to be the change in refraction in the second year of life; in the same way the difference between a given refraction first determined some time between the twelfth and the twenty-fourth month of life and next determined some time between the twenty-fourth and the thirty-sixth month was considered as a change occurring in the third year of life. With the use of atropine as a cycloplegic, the reversal of the retinoscopic shadow can be determined with accuracy to a 0.25 diopter and has been recorded by my associates and me in 0.25 diopter intervals.

RESULTS

From birth to the end of the seventh year hyperopia increased (refraction decreased) in the average case. From 8 to 14 years the refraction moved toward the myopic side at a rapid rate (increased), and this increase continued, though at less than half the rate, up to the age of 20. Thereafter the amount of change was negligible, but the nature of the changes was interesting; up to the age of 33 there was a slight yearly increase of refraction (except, according to our figures, for the thirtieth year); from 34 to 42 years the change was uniformly a net average decrease, though this was slight; from 43 to 51 years inclusive it was again a slight net average increase of refraction (increase of myopia, decrease of hyperopia) in each successive year, although the amount was very slight. In tables 2 to 7 are summarized the changes in the respective age groups, year by year; in table 1 are given the data for the groups as units.

A somewhat more detailed consideration and discussion of the results in the particular age groups are given in the following paragraphs.

Decrease of Refraction from Birth to the End of the Seventh Year.—The present study of this age group was based on 1,668 retinoscopic computations and showed an increase of hyperopia (decrease of refraction) for every year in comparison with that found the year before. In the third year this change was greater than in the second, but after the third year the change in each successive year was

less. The net average decrease of refraction for the years was respectively, 0.41, 0.43, 0.27, 0.21, 0.13 and 0.02 diopter (general yearly average, 0.18 diopter).

This increase of hyperopia (decrease of refraction) is directly counter to the accepted world-wide view. Parsons [5] said (1933): "From the statistical point of view, however, the generalization that the normal eye is hyperopic at birth and tends constantly during the early years of life toward a condition of diminished hyperopia may be regarded as true." This has not been the observation of my associates and myself. Thus, in a paper written in collaboration with Kronfeld [6] I challenged this prevailing view on the basis of the changes in 193 eyes, each reexamined one or more times under atropine during the first five years of life; 110 eyes showed either an increase of hyperopia or no change. In 1932 Bothman,[7] at a second determination, also found an increase of hyperopia in both meridians in 71 per cent of 248 atropinized eyes of children under 6 years of age. Again in 1936 I [8] found an apparent increase of hyperopia in 63 per cent of 604 eyes of children up to 9 years of age. The patients used in the present study include all those observed in the three previous studies along with additional patients, but, as stated previously, the entire material has been analyzed in a more accurate way; thus if a given subject had the first refraction test, say, at the age of 6 years but no second test before 9, the amount of change found was divided by 3, and this amount was credited to each of the respective three years. Thus a large but legitimate increase in

TABLE 1.—*Changes in Refraction on the Basis of Age Groups*

Age	Computations	Change in Diopters	Type of Change*
Birth to 7	1,668	0.18	Decrease
8 to 13	2,862	0.23	Increase
14 to 20	2,068	0.14	Increase
21 to 33	1,687	0.04	Increase
34 to 42	441	0.03	Decrease
43 to 51	94	0.03	Increase
Birth to 51	8,820	0.09	Increase

* Decrease means more hyperopia or less myopia; increase, less hyperopia or more myopia.

5. Parsons, John: Developmental Myopia and the Treatment of Myopes, Lancet **2**:795 (Oct. 17) 1933.

6. Brown, E. V. L., and Kronfeld, P. C.: Refractive Curve in the U. S. A. with Special Reference to Changes in the First Two Decades, Compt. rend. Concilium Ophth. **13**:87, 1929.

7. Bothman, L.: Refraction Changes in the Eyes of Children Under Six Years of Age, Arch. Ophth. **7**:294 (Feb.) 1932.

8. Brown, E. V. L.: Apparent Increase of Hyperopia up to the Age of Nine Years, Am. J. Ophth. **19**:1106 (Dec.) 1936.

the number of deduced observations was obtained for study along with the other data obtained from the comparison of the refraction in two subsequent years.

In over two thirds of the children under 8 years of age (1,213 of 1,668 observations) strabismus was present, but neither its presence or absence nor the sex of the patient seemed to modify significantly this trend toward a decrease of refraction. Decrease of refraction was present in the group as a whole throughout each year, in male and female alike in each year and in strabismic and in nonstrabismic eyes (chart 1). I therefore again seriously challenge the prevailing view that decrease of hyperopia is the rule in the early years of life and present further evidence that a decrease of refraction (increase of hyperopia) is the rule up to the end of the seventh year of life (chart 2).

Beginning with the eighth year of life, our findings show that the net average change was no longer one toward more hyperopia but was one toward less hyperopia or more myopia. From the age of 8 to 13 inclusive the net yearly averages of these increases in refraction were: 0.10 diopter in the eighth year, 0.19 in the ninth, 0.27 in the tenth, 0.27 in the eleventh, 0.28 in the twelfth and 0.29 in the thirteenth. The net average change for the period was an increase of refraction of 0.23 diopters per year.

Slower Increase of Refraction from 14 to 20.—In our present data the rate of increase of refraction toward myopia decreased markedly after 13 years; indeed up to the age of 20 the rate is only slightly more than half the average amount found between 8 and 13 years (0.14 vs. 0.23 diopter per year). The amount of the net yearly increase for the average eye in the successive years, 14 to 20, was as follows (table 4): 0.23 diopter in the fourteenth year, 0.17 in the fifteenth, 0.17 in the sixteenth, 0.15 in the seventeenth, 0.10 in the eighteenth, 0.10 in the nineteenth and 0.08 in the twentieth.

Cessation of Increase of Myopia at 20.—The material covering the twenty-first to the thirty-third year inclusive comprised 1,687 observations and calculations. Net (average) increases of refraction were noted in every year except in the thirtieth, when the figures showed a slight net decrease (0.0001 diopter for the average eye). The yearly changes were slight, e. g., 0.05, 0.06, 0.07, 0.05, 0.04, 0.02, 0.02, 0.04, 0.005, 0.0001 (decrease in the thirtieth year), 0.02, 0.02 and 0.02 diopter per year in the successive years. The net average change for the group as a whole was an increase of refraction of only 0.04 diopter per year (table 5). At this slow rate it would require twelve years to effect an increase of 0.5 diopter in myopia or a decrease of 0.5 diopter in hyperopia, and this is, of course, practically a negligible change. There was no evidence whatever in this series that myopia regularly progresses after the age of 20.

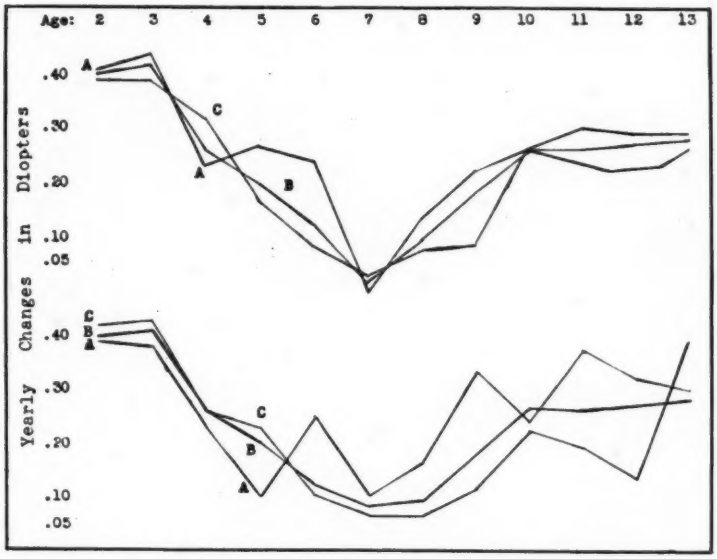

Chart 1.—The upper three curves show the yearly changes in the eyes of the females as compared with those in the eyes of the males for an age group of from 2 to 13 years. *A* is the curve for the females; *B*, the curve for the entire group, and *C*, the curve for the males. The lower three curves show the yearly changes in strabismic eyes as compared with those in nonstrabismic eyes for the same age group. *A* is the curve for the nonstrabismic eyes; *B*, the curve for all eyes, and *C*, the curve for the strabismic eyes.

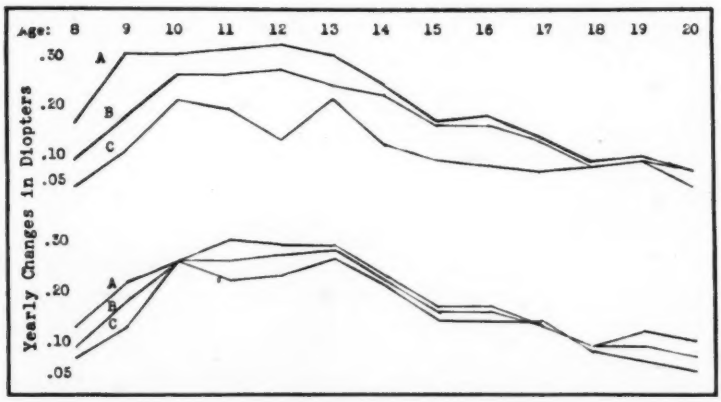

Chart 2.—The upper three curves show the yearly changes in strabismic eyes as compared with those in nonstrabismic eyes for an age group of from 8 to 20 years. *A* is the curve for the nonstrabismic eyes; *B*, the curve for all eyes, and *C*, the curve for the strabismic eyes. The lower three curves show the yearly changes in the eyes of females as compared with those in the eyes of males for the same age group. *A* is the curve for the females; *B*, the curve for the entire group, and *C*, the curve for the males.

TABLE 2.—*Changes in Refraction from Birth to the End of the Seventh Year*

		Male						Female						Male and Female, With and Without Strabismus	
		Without Strabismus		With Strabismus		Totals		Without Strabismus		With Strabismus		Totals			
Year of Life	Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Net Average Yearly Change and Type of Change
2d	Increases	0	....	9	0.90	9	0.90	4	0.41	4	0.90	8	0.66	17	0.72
	Decreases	0	....	25	0.90	25	0.90	8	0.26	25	0.80	33	0.66	58	0.76
	No change	0		2		2		0		2		2		4	
	Totals	0	....	36	....	36	0.40 d	12	0.04 d	31	0.53 d	43	0.42 d	79	0.41 d
3d	Increases	...	....	12	0.38	12	0.38	4	0.24	4	0.52	8	0.38	20	0.38
	Decreases	4	0.41	49	0.64	53	0.64	12	0.58	67	0.57	79	0.57	132	0.62
	No change	0		8		8		0		7		7		15	
	Totals	4	0.41 d	69	0.40 d	73	0.40 d	16	0.38 d	78	0.46 d	94	0.45 d	167	0.43 d
4th	Increases	1	0.25	11	0.19	12	0.20	5	0.20	32	0.37	37	0.35	49	0.31
	Decreases	9	0.39	53	0.50	62	0.48	12	0.37	84	0.51	96	0.41	158	0.49
	No change	1		10		11		1		12		13		24	
	Totals	11	0.30 d	74	0.33 d	85	0.33 d	18	0.20 d	128	0.24 d	146	0.24 d	231	0.27 d
5th	Increases	19	0.21	36	0.16	55	0.18	15	0.15	44	0.31	59	0.24	114	0.24
	Decreases	49	0.28	82	0.38	131	0.32	17	0.38	150	0.48	167	0.47	298	0.41
	No change	9		15		24		6		15		21		45	
	Totals	77	0.13 d	133	0.19 d	210	0.17 d	38	0.11 d	209	0.28 d	247	0.28 d	457	0.21 d
6th	Increases	10	0.28	41	0.28	51	0.28	17	0.25	49	0.34	66	0.32	117	0.30
	Decreases	18	0.21	55	0.43	73	0.38	102	0.44	13	0.48	115	0.44	188	0.42
	No change	4		14		18		8		18		26		44	
	Totals	32	0.03 d	110	0.10 d	142	0.09 d	127	0.32 d	80	0.13 d	207	0.25 d	349	0.13 d
7th	Increases	28	0.30	46	0.29	74	0.28	40	0.46	50	0.39	90	0.42	164	0.39
	Decreases	23	0.25	62	0.37	85	0.55	19	0.43	78	0.40	97	0.41	182	0.37
	No change	5		8		13		7		21		28		41	
	Totals	56	0.05 i	116	0.07 d	172	0.03 d	66	0.16 i	149	0.08 d	215	0.0005 d	387	0.18 d

TABLE 3.—*Changes in Refraction from the Eighth to the End of the Thirteenth Year*

Year of Life	Type of Change	Male						Female						Male and Female, With and Without Strabismus	
		Without Strabismus		With Strabismus		Totals		Without Strabismus		With Strabismus		Totals			
		Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Net Average Yearly Change and Type of Change
8th	Increases	51	0.37	67	0.31	118	0.28	69	0.38	86	0.36	155	0.37	273	0.35
	Decreases	36	0.25	34	0.41	70	0.33	16	0.14	53	0.33	69	0.29	139	0.31
	No change	9		16		25		14		18		32		57	
	Totals	96	0.10 i	117	0.06 i	213	0.08 i	99	0.24 i	157	0.08 i	256	0.14 i	469	0.10 i
9th	Increases	104	0.38	74	0.30	178	0.35	113	0.50	81	0.38	194	0.45	109	0.40
	Decreases	22	0.22	29	0.40	51	0.32	20	0.25	38	0.28	58	0.27	372	0.27
	No change	12		12		24		11		17		28		52	
	Totals	138	0.25 i	115	0.09 i	253	0.14 i	144	0.36 i	136	0.15 i	280	0.23 i	533	0.19 i
10th	Increases	79	0.46	65	0.46	144	0.46	115	0.47	71	0.40	186	0.44	330	0.40
	Decreases	23	0.19	20	0.29	43	0.21	20	0.24	25	0.29	45	0.27	88	0.20
	No change	10		11		21		13		14		27		48	
	Totals	112	0.29 i	96	0.25 i	208	0.27 i	148	0.33 i	110	0.19 i	258	0.27 i	466	0.27 i
11th	Increases	104	0.43	49	0.26	153	0.38	137	0.37	68	0.39	205	0.38	358	0.37
	Decreases	14	0.19	24	0.31	38	0.27	16	0.26	18	0.25	34	0.25	72	0.26
	No change	10		6		16		10		10		20		36	
	Totals	128	0.28 i	79	0.16 i	207	0.23 i	163	0.35 i	96	0.23 i	259	0.31 i	466	0.27 i
12th	Increases	117	0.44	37	0.29	154	0 40	160	0.43	47	0.35	207	0.41	361	0.41
	Decreases	29	0.18	16	0.31	45	0.23	7	0.28	17	0.20	24	0.23	69	0.23
	No change	11		4		15		17		7		24		39	
	Totals	157	0.29 i	57	0.10 i	214	0 24 i	184	0.36 i	71	0.18 i	255	0.30 i	469	0 28 i.
13th	Increases	126	0.41	39	0.35	165	0.40	162	0.43	39	0.31	201	0.41	366	0.40
	Decreases	31	0.25	3	0.07	34	0.23	13	0.32	16	0.25	29	0.28	63	0.26
	No change	7		3		10		13		4		17		27	
	Totals	164	0.26 i	45	0.30 i	209	0.27 i	188	0.35 i	59	0.14	247	0.30 i	456	0.29 i

TABLE 4.—*Changes in Refraction from the Fourteenth to the Twentieth Year Inclusive*

Year of Life	Type of Change	Male						Female						Male and Female, With and Without Strabismus	
		Without Strabismus		With Strabismus		Totals		Without Strabismus		With Strabismus		Totals			
		Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Net Average Yearly Change and Type of Change
14th	Increases	121	0.38	28	0.30	149	0.37	145	0.38	32	0.06	177	0.32	326	0.34
	Decreases	20	0.22	1	0.04	21	0.21	17	0.20	8	0.10	25	0.17	46	0.08
	No change	10		2		12		15		3		18		30	
	Totals	151	0.21 i	31	0.27 i	182	0.22 i	177	0.29 i	43	0.03 i	220	0.24 i	402	0.23 i
15th	Increases	103	0.28	15	0.19	118	0.27	133	0.34	22	0.24	155	0.33	273	0.29
	Decreases	24	0.27	5	0.08	29	0.24	21	0.47	12	0.14	33	0.35	62	0.30
	No change	12		3		15		21		3		24		39	
	Totals	139	0.16 i	23	0.11 i	162	0.15 i	175	0.20 i	37	0.10 i	212	0.18 i	374	0.17 i
16th	Increases	88	0.22	19	0.19	107	0.21	132	0.28	24	0.24	156	0.27	263	0.26
	Decreases	16	0.16	3	0.26	19	0.18	16	0.25	8	0.12	24	0.21	43	0.19
	No change	8		1		9		24		3		27		26	
	Totals	112	0.15 i	23	0.18 i	135	0.15 i	172	0.19 i	35	0.14 i	207	0.18 i	342	0.17 i
17th	Increases	84	0.24	9	0.14	93	0.23	111	0.22	21	0.23	132	0.22	225	0.24
	Decreases	16	0.20	3	0.26	19	0.21	21	0.12	7	0.28	28	0.16	47	0.18
	No change	8		..		8		14		1		15		23	
	Totals	108	0.16 i	12	0.04 i	120	0.15 i	146	0.15 i	29	0.10 i	175	0.14 i	295	0.15 i
18th	Increases	76	0.20	10	0.15	86	0.19	88	0.19	10	0.17	98	0.18	184	0.19
	Decreases	23	0.21	3	0.12	26	0.20	22	0.16	4	0.09	26	0.15	52	0.17
	No change	13		1		14		10		1		11		25	
	Totals	112	0.09 i	14	0.08 i	126	0.09 i	120	0.11 i	15	0.09 i	135	0.10 i	261	0.10 i
19th	Increases	55	0.18	7	0.15	62	0.18	68	0.22	8	0.10	76	0.21	138	0.19
	Decreases	22	0.16	2	0.06	24	0.15	17	0.11	6	0.10	23	0.11	57	0.11
	No change	14		1		15		5		1		6		71	
	Totals	91	0.07 i	10	0.09 i	101	0.07 i	90	0.15 i	15	0.01 i	105	0.13 i	206	0.10 i
20th	Increases	46	0.17	6	0.16	52	0.17	53	0.21	8	0.07	61	0.19	113	0.18
	Decreases	25	0.17	0	0	25	0.17	18	0.10	4	0.09	22	0.10	47	0.13
	No change	12		1		13		13		2		15		28	
	Totals	83	0.04 i	7	0.14 i	90	0.05 i	84	0.12 i	14	0.01 i	98	0.11 i	188	0.08 i

TABLE 5.—*Changes in Refraction from the Twenty-First to the Thirty-Third Year Inclusive*

Year of Life	Type of Change	Male						Female						Male and Female, With and Without Strabismus	
		Without Strabismus		With Strabismus		Totals		Without Strabismus		With Strabismus		Totals			
		Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Net Average Yearly Change and Type of Change
21st	Increases	37	0.13	5	0.12	42	0.13	52	0.14	6	0.11	58	0.14	100	0.13
	Decreases	24	0.14	0	0	24	0.14	7	0.27	2	0.02	9	0.21	33	0.16
	No change	11		..		11		12		4		16		27	
	Totals	72	0.02 i	5	0.02 i	77	0.03 i	71	0.08 i	12	0.05 i	83	0.07 i	160	0.05 i
22d	Increases	43	0.16	2	0.12	45	0.16	52	0.15	2	0.11	54	0.15	99	0.14
	Decreases	23	0.12	0	0	23	0.12	19	0.10	3	0.14	22	0.12	45	0.11
	No change	2		..		2		11		8		19		21	
	Totals	68	0.03 i	2	0.12 i	70	0.06 i	82	0.07 i	13	0.26 d	95	0.06 i	165	0.06 i
23d	Increases	41	0.19	2	0.12	43	0.19	51	0.12	2	0.04	53	0.12	96	0.15
	Decreases	25	0.13	0	0	25	0.13	17	0.07	3	0.14	20	0.08	45	0.12
	No change	4		..		4		8		6		14		18	
	Totals	70	0.06 i	2	0.12 i	72	0.07 i	76	0.06 i	11	0.03 d	87	0.05 i	159	0.07 i
24th	Increases	45	0.19	2	0.12	47	0.19	52	0.12	2	0.39	54	0.13	101	0.15
	Decreases	26	0.10	0	0	26	0.10	20	0.16	3	0.14	23	0.16	49	0.13
	No change	8		..		8		7		3		10		18	
	Totals	79	0.08 i	2	0.12 i	81	0.07 i	79	0.04 i	8	0.05 i	87	0.04 i	168	0.05 i
25th	Increases	39	0.18	1	0.09	40	0.18	47	0.11	2	0.11	49	0.11	89	0.14
	Decreases	24	0.09	1	0.14	25	0.09	20	0.12	2	0.22	22	0.13	47	0.11
	No change	10		..		10		7		4		11		21	
	Totals	73	0.07 i	2	0.03 d	75	0.05 i	74	0.04 i	8	0.03 d	82	0.03 i	157	0.04 i
26th	Increases	28	0.09	3	0.09	31	0.09	32	0.12	2	0.12	34	0.12	65	0.11
	Decreases	27	0.12	0	0.12	27	0.12	13	0.08	1	0.01	14	0.08	41	0.10
	No change	10		3		13		4		2		6		19	
	Totals	65	0.01 d	6	0.05	71	0.006 d	49	0.06 i	5	0.06 i	54	0.06 i	125	0.02 i

27th	Increases	28	0.14	2	0.12	30	0.14	23	0.14	3	0.09	26	0.13	56	0.13
	Decreases	16	0.16	0	0	16	0.16	15	0.12	1	0.01	16	0.11	32	0.14
	No change	10		..		10		6		5		11		21	
	Totals	54	0.03 i	2	0.12 i	56	0.03 i	44	0.01 i	9	0.07 i	53	0.01 i	139	0.02 i
28th	Increases	32	0.13	2	0.12	34	0.13	26	0.13	0	0	26	0.13	60	0.13
	Decreases	18	0.06	0	0	18	0.06	18	0.12	1	0.01	19	0.11	37	0.09
	No change	10		..		10		8		1		9		19	
	Totals	60	0.05 i	2	0.12 i	62	0.05 i	52	0.02 i	2	0.01 d	54	0.02 i	116	0.04 i
29th	Increases	14	0.14	2	0.12	16	0.14	32	0.11	0	0	32	0.11	48	0.12
	Decreases	23	0.14	0	0	23	0.14	24	0.13	1	0.01	25	0.13	48	0.13
	No change	8		..		8		10		3		13		21	
	Totals	45	0.008 d	2	0.12 i	47	0.003 d	66	0.006 i	4	0.01 d	70	0.006 i	117	0.005 i
30th	Increases	21	0.12	2	0.12	23	0.12	24	0.11	0	0	24	0.24	47	0.11
	Decreases	14	0.17	0	0	14	0.17	26	0.12	1	0	27	0.12	41	0.13
	No change	6		..		6		13		3		16		22	
	Totals	41	0.006 i	2	0.12 i	43	0.006 i	63	0.006 d	4	0.003 d	67	0.006 d	110	0.0001 d
31st	Increases	17	0.10	2	0.12	19	0.10	26	0.14	0	0	26	0.14	45	0.13
	Decreases	8	0.10	0	0	8	0.10	25	0.11	4	0.12	29	0.11	37	0.11
	No change	5		..		5		10		2		12		17	
	Totals	30	0.09 i	2	0.12 i	32	0.04 i	61	0.01 i	6	0.02 d	67	0.01 i	99	0.02 i
32d	Increases	19	0.13	0	0	19	0.13	23	0.12	0	0	23	0.12	42	0.12
	Decreases	5	0.09	0	0	5	0.09	23	0.09	4	0.13	27	0.09	32	0.09
	No change	4		..		4		12		1		13		17	
	Totals	28	0.07 i	0	0	28	0.07 i	58	0.01 i	5	0.01 d	63	0.003 i	91	0.02 i
33d	Increases	12	0.14	0	0	12	0.14	19	0.15	0	0	19	0.15	31	0.15
	Decreases	10	0.07	0	0	10	0.07	27	0.08	1	0.01	28	0.08	38	0.07
	No change	5		..		5		7		..		7		12	
	Totals	27	0.04 i	0	0	27	0.04	53	0.01 i	1	0.01 d	54	0.01 i	81	0.02 i

TABLE 6.—*Changes in Refraction from the Thirty-Fourth to the Forty-Second Year Inclusive*

Year of Life	Type of Change	Male						Female						Male and Female, With and Without Strabismus	
		Without Strabismus		With Strabismus		Totals		Without Strabismus		With Strabismus		Totals			
		Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Net Average Yearly Change and Type of Change
34th	Increases	8	0.17	0	0	8	0.17	15	0.09	0	0	15	0.09	23	0.11
	Decreases	1	0.02	0	0	1	0.02	28	0.07	4	0.13	32	0.08	33	0.07
	No change	2		..		2		9		1		10		12	
	Totals	11	0.12 i	0	0	11	0.12 i	52	0.02 d	5	0.10 d	57	0.02 d	68	0.003 d
35th	Increases	0	0	0	0	0	0	18	0.11	0	0	18	0.11	37	0.12
	Decreases	0	0	0	0	0	0	37	0.12	0	0	37	0.12	18	0.11
	No change	0		..		..		11		..		11		11	
	Totals	0	0	0	0	0	0	66	0.04 d	0	0	66	0.04 d	66	0.04 d
36th	Increases	4	0.05	0	0	4	0.05	14	0.12	0	0	14	0.12	18	0.10
	Decreases	5	0.31	0	0	5	0.31	26	0.10	1	0.12	27	0.10	32	0.13
	No change	5		..		5		5		..		5		10	
	Totals	14	0.10 d	0	0	14	0.10 d	45	0.02 d	1	0.12 d	46	0.02 d	60	0.04 d
37th	Increases	0	0	0	0	0	0	17	0.08	0	0	17	0.08	17	0.08
	Decreases	2	0.71	0	0	2	0.71	24	0.07	0	0	24	0.07	26	0.12
	No change	1		..		1		6		..		6		7	
	Totals	3	0.47 d	0	0	3	0.47 d	47	0.007 i	0	0	47	0.007 i	50	0.02 d
38th	Increases	0	0	0	0	0	0	15	0.06	0	0	15	0.06	15	0.06
	Decreases	2	0.72	0	0	2	0.72	23	0.07	0	0	23	0.07	25	0.12
	No change	1		..		1		8		..		8		9	
	Totals	3	0.48 d	0	0	3	0.48 d	46	0.01 d	0	0	46	0.01 d	49	0.04 d
39th	Increases	0	0	0	0	0	0	14	0.06	0	0	14	0.06	14	0.06
	Decreases	2	0.60	0	0	2	0.60	19	0.07	0	0	19	0.07	21	0.12
	No change	0		..		0		9		..		9		9	
	Totals	2	0.60 d	0	0	2	0.60	42	0.01 d	0	0	42	0.01 d	44	0.04 d
40th	Increases	0	0	0	0	0	0	15	0.10	1	0.31	16	0.11	16	0.11
	Decreases	1	0.83	0	0	1	0.83	14	0.10	0	0	14	0.10	15	0.15
	No change	1		..		1		10		1		11		12	
	Totals	2	0.42 d	0	0	2	0.42 d	39	0.003 d	2	0.16 i	41	0.01 i	43	0.01 d
41st	Increases	3	0.27	0	0	3	0.27	8	0.12	1	0.31	9	0.14	12	0.17
	Decreases	2	0.44	0	0	2	0.44	13	0.17	0	0	13	0.17	15	0.20
	No change	1		..		1		6		..		6		7	
	Totals	6	0.01 d	0	0	6	0.01 d	27	0.05 d	1	0.31 i	28	0.03 d	34	0.03 d
42d	Increases	0	0	0	0	0	0	12	0.11	0	0	12	0.11	12	0.17
	Decreases	2	0.42	0	0	2	0.42	11	0.09	0	0	11	0.09	11	0.15
	No change	0		..		0		4		..		4		4	
	Totals	2	0.42 d	0	0	2	0.42	27	0.01 d	0	0	27	0.01 i	27	0.02 d

Decrease of Refraction Between 34 and 42.—Only 441 observations formed the basis of the study of this age group. But, surprisingly, the net average change consisted of a decrease of refraction (more hyperopia or less myopia) for each and every year without exception. The net amounts were again slight, e. g., only 0.003, 0.04, 0.04, 0.02, 0.04, 0.04, 0.01, 0.03 and 0.02 diopter (an average of 0.03 diopter) for the successive years (table 6).

Slight Increase of Refraction Between 43 and 51.—In this last period only 94 observations were made. But in every year the trend of the previous age group was reversed, and a slight increase was noted. The findings were, respectively, 0.04, 0.03, 0.01, 0.09, 0.02, 0.01, 0.04, 0.08 and 0.08 diopter (average, 0.03) of net average increase of refraction for the successive years (table 7). In view of the small number of observations, one cannot, of course, be at all confident of the reliability of conclusions.

Interpretation of the Average Changes in the Various Periods.—In my opinion the decrease of hyperopia noted through the first seven years of life is not due to less effective cycloplegia in the earliest years. It could be due to (1) a decrease in the curvature of the cornea, (2) a decrease in the curvature of the surfaces of the lens and (3) a relative backward displacement of the lens. It does not seem that a decrease in the refraction of the aqueous, lens or vitreous could play any part. It is inconceivable that the eye becomes shorter. A small beginning has been made by us toward a comparison of the curvature of the cornea in a few persons in the series with that of the same person at a later age, but the data are not sufficient to warrant a report or comment. Steiger made a study of the corneal curvature years ago, but it consisted of a comparison of changes found in a given age group with those in what must have been another group of persons at a later age. No satisfactory method of measuring the curvature of the posterior or anterior surface of the lens has been devised. That of Tscherning has been used for an extended study by Tron,[9] but the shortcomings and entire inadequacy of the method have been pointed out by Gullstrand and by Nordenson.[10] Katz, assisted by Ledoux,[11] in my clinic, has devised a method for estimating the length of the eye intra vitam. An opaque substance is injected behind the eye, a

9. Tron, E.: Variationsstatistische Untersuchungen über Refraktion, Arch. f. Ophth. **122**:1 (May) 1929.

10. Nordenson, J. E.: Die Untersuchungsmethoden, in von Graefe, A., and Saemisch, E. T.: Handbuch der gesamten Augenheilkunde, ed. 3, Leipzig, Wilhelm Engelmann, 1925, vol. 2, p. 215.

11. Katz, D., and Ledoux, A. C.: Measurement (Roentgenometry) of Antero-Posterior Diameter of the Eyeball in Situ Correlated with Micrometer Measurement Following Enucleation, Am. J. Ophth. **18**:914 (Oct.) 1935.

TABLE 7.—*Changes in Refraction from the Forty-Third to the Fifty-First Year Inclusive*

Year of Life	Type of Change	Male						Female						Male and Female, With and Without Strabismus	
		Without Strabismus		With Strabismus		Totals		Without Strabismus		With Strabismus		Totals			
		Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Average Change and Type of Change	Number of Computations	Net Average Yearly Change and Type of Change
43d	Increases	0	0	0	0	0	0	11	0.23	0	0	11	0.23	11	0.23
	Decreases	2	0.44	0	0	2	0.44	7	0.13	0	0	7	0.13	9	0.19
	No change	0		..		0		3		..		3		3	
	Totals	2	0.44 d	0	0	2	0.44 d	21	0.08 i	0	0	21	0.08 i	23	0.04 i
44th	Increases	0	0	0	0	0	0	11	0.10	0	0	11	0.10	11	0.10
	Decreases	0	0	0	0	0	0	4	0.15	0	0	4	0.15	4	0.15
	No change	0		..		0		2		..		2		2	
	Totals	0	0	0	0	0	0	17	0.03 i	0	0	17	0.03 i	17	0.03 i
45th	Increases	0	0	0	0	0	0	12	0.13	0	0	12	0.13	12	0.13
	Decreases	0	0	0	0	0	0	1	0.08	0	0	1	0.08	1	0.08
	No change	1		..		1		2		..		2		3	
	Totals	1	0	0	0	1	0	15	0.01 i	0	0	15	0.01	16	0.01 i
46th	Increases	0	0	0	0	0	0	5	0.14	0	0	5	0.14	5	0.14
	Decreases	0	0	0	0	0	0	1	0.06	0	0	1	0.06	1	0.06
	No change	0		..		0		1		..		1		1	
	Totals	0	0	0	0	0	0	7	0.09 i	0	0	7	0.09 i	7	0.09 i
47th	Increases	0	0	0	0	0	0	7	0.15	0	0	7	0.15	7	0.15
	Decreases	0	0	0	0	0	0	2	0.45	0	0	2	0.41	2	0.41
	No change	0		..		0		1		..		1		1	
	Totals	0	0	0	0	0	0	10	0.02 i	0	0	10	0.02 i	10	0.02 i
48th	Increases	0	0	0	0	0	0	7	0.08	0	0	7	0.08	7	0.08
	Decreases	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No change	0		..		0		2		..		2		2	
	Totals	0	0	0	0	0	0	9	0.01 i	0	0	9	0.01 i	9	0.01 i
49th	Increases	0	0	0	0	0	0	4	0.09	0	0	4	0.09	4	0.09
	Decreases	0	0	0	0	0	0	1	0.06	0	0	1	0.06	1	0.06
	No change	0		..		0		2		..		2		2	
	Totals	0	0	0	0	0	0	7	0.04 i	0	0	7	0.04 i	7	0.04 i
50th	Increases	2	0.08	0	0	2	0.08	1	0.08	0	0	1	0.08	3	0.08
	Decreases	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No change	0		..		0		0		..		0		0	
	Totals	2	0.08	0	0	2	0.08 i	1	0.08 i	0	0	1	0.08 i	3	0.08 i
51st	Increases	2	0.08	0	0	2	0.08	0	0	0	0	0	0	2	0.08
	Decreases	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	No change	0		..		0		0		..		0		0	
	Totals	2	0.08 i	0	0	2	0.08 i	0	0	0	0	0	0	2	0.08 i

roentgenogram is taken and the length of the eye as a whole is measured. The method has been developed to a high degree of proved accuracy (0.1 mm.) in lower animals, which is still insufficient, along with a method for the obtaining of two accurately determinable measurements (corneal curvature and total retinoscopic refraction) for use in the calculation of the third main factor in refraction, the curvature of the lens. If greater refinement of this method can be brought about, it is clear that a real contribution can be made to the study of refraction as well as to that of other problems, as Katz pointed out. It would then be easy to prove or disprove the contention of Tron, now based on insufficient or inacceptable data, that the emmetropic and the myopic eye may be as short as 21 and 22 mm., respectively.

Myopia develops mainly during the school years, according to the adherents of both the hereditary and the environmental theory of the causation of myopia, and our findings corroborate this so far as the net average yearly changes are concerned. For example, we find no tendency in the average eye toward myopia before the age of 8 and a rapid increase of refractive change (toward less hyperopia and more myopia) from 8 to 13 years; but while the increase continues up to the age of 20 it is steadily, progressively and uniformly less in amount each year in comparison with that found the previous year. On the whole, the increase is little more than half the rate of the previous period.

In searching for the reason for this trend toward emmetropization in the group as a whole, it at once comes to mind that only one thing regularly intervenes at from 12 to 14 years of age, and that is puberty. Is it not logical to assume that just as every other cell and tissue in the body is especially vitalized by the "sex hormones" at this time (and possibly somewhat decreasingly so for the next six or eight years), so too the eye is subjected to influences which tend toward "emmetropization?"

The data on changes after the age of 20 would show that net average yearly changes are negligible to at least an age well beyond middle life. The only statement with which I am familiar concerning the age beyond which myopia does not develop is that of Salzmann to the effect that myopia does not increase beyond the age of 25. The present data would place this at 20. Between 20 and 33 years a slight net average increase was noted (0.04 diopter per year). But between 34 and 42 years the reverse was the case; i. e., there was a net average yearly decrease in each successive year, although the amount was slight (0.03 diopter, on the average) per year. Here it is conceivable that accommodation is weaker, cycloplegia more effective or both. From the age of 43 to and including the fifty-first year, a small group of 94 observa-

tions again showed an increase of refraction, slight in amount (0.09 diopter). Increase of the index of refraction of the lens may possibly account for this, though deductions are scarcely permissible from such a small number of observations. Still the change was constant for each year.

SUMMARY AND CONCLUSIONS

Two or more retinoscopic tests were made on one or both atropinized eyes of 1,203 persons at intervals one or more years apart, and on the basis of 8,820 changes computed the net average yearly changes in refraction from birth to the end of the fifty-first year have been studied.

My conclusions are that in the average person who comes to the ophthalmologist the following changes in refraction take place:

1. Hyperopia increases each year until the end of the seventh year, contrary to the generally accepted view.

2. Myopia increases and hyperopia decreases (refraction increases) rapidly from 8 to 13 years, as generally held.

3. From 14 to 20 years this increase continues each year but at a rate barely half that of the previous period. Puberty possibly tends to bring about an "emmetropization."

4. Increase of myopia after the age of 20 is practically negligible, and the average changes in refraction are of a minor amount. Increase in myopia has heretofore been held to continue to a later age. There are definite trends and reversals in the nature of these changes as follows:

(*a*) Between 20 and 33 years the increase continues at a very low average yearly rate (0.04 diopter).

(*b*) Between 34 and 42 years the refraction shifts to a low yearly decrease in each successive year, averaging only 0.03 diopter; this is possibly due to the weakening of accommodation.

(*c*) Between 43 and 51 years there is again a slight yearly increase in each successive year, averaging 0.09 diopter, possibly due to an increase in the index of refraction of the lens.

MOLDED CONTACT LENSES

THEODORE E. OBRIG, A.B.
NEW YORK

The molded contact lens is rapidly advancing from an experimental status to that of a device of proved worth. This type of lens represents the ideal conception of a perfect contact lens because the scleral portion can be molded to the shape of each patient's sclera, with allowance for the play of the extrinsic muscles and the forces exerted by the eyelids, maximum comfort thus being insured. At the same time the corneal portion can be optically ground to correct ametropia with exactness, maximum visual acuity being insured. Lenses can be made in various sizes to meet individual requirements. The limits in this respect are governed only by the size of the cast provided. The finished lens is made of one piece of chemically resistant hard crown glass with a refractive index of 1.516.

Data obtained as a result of making casts of approximately 250 eyes not easily fitted with ground contact lenses have made it possible to determine why these particular eyes were difficult to fit. It has also revealed a probable reason for the wide differences of individual tolerance when the fit of the scleral portion of the ground contact lens is good.

It is my opinion that the primary difficulty in obtaining comfort with a contact lens is due to pressure at the limbus, particularly nasally and temporally. This opinion is borne out by careful measurement of horizontal and vertical corneal diameters as seen on positive plaster casts of the anterior portion of the eye. It is extremely difficult to measure the diameter of the cornea from limbus to limbus on the eye itself. When this measurement was attempted in a number of instances the results varied from those obtained from a casting by as much as 3 mm. However, castings of the eye show a clear and defined line of demarcation about the entire circumference of the cornea. This furrow, called the external scleral sulcus, is seen as a depression due to the difference of curvature between the scleral and the corneal segment.

Contrary to the measurements generally accepted, the average diameters of the corneas measured were 12 and 13.55 mm., the smallest and longest horizontal diameters being 11.5 and 15.25 mm., respectively. Vertically, the range was from 10.5 to 13.5 mm. The accompanying table shows the proportion of the many variations measured. It can be

seen at a glance that most of the corneas measured from 11.5 to 12.5 mm. vertically and from 13 to 14 mm. horizontally. All differences of 0.25 mm. are recorded as in the division smaller, to avoid overstatement.

When it is remembered that the corneal portion of the ground Zeiss contact lens is 12 mm. in diameter, is it any wonder that a large number of patients with lenses with well fitted scleral portions are unable to wear them with comfort?

The following case report will serve to exemplify this situation: A young woman whose history revealed no contraindication to the use of contact lenses obtained an exceptionally good fit in the scleral portion with Zeiss trial contact lenses. During the trial period for a test of tolerance some inflammation was observed at the end of half an hour's wear. Examination with fluorescein showed clearance of the

Measurements of Two Hundred Corneas from Casts

		Vertical Diameter of Cornea in Millimeters							Total	
		10.5	11.0	11.5	12.0	12.5	13.0	13.5	No.	Percentage
Horizontal diameter of cornea in millimeters	11.5	1	..	..	..	..	..	..	1	0.5
	12.0	..	6	2	..	..	..	..	8	4.0
	12.5	3	5	6	3	..	..	..	17	8.5
	13.0	..	5	11	18	4	..	..	38	19.0
	13.5	2	..	7	38	14	1	..	62	31.0
	14.0	..	..	3	25	14	6	..	48	24.0
	14.5	..	..	..	3	8	4	1	16	8.0
	15.0	..	..	..	2	2	3	3	10	5.0
Total		6	16	29	89	42	14	4		
Percentage		3	8	14.5	44.5	21	7	2		

Average diameters of cornea..... 12 and 13.55 mm.
Average difference between vertical and horizontal diameter..... 1.55 mm.

cornea and some pressure at the limbus. As the ciliary body was injected, this pressure was considered the cause of the irritation. The horizontal diameter of each cornea as measured with a ruler was 13 mm., and the patient was advised to order continuous transition lenses, which should clear a cornea of this width and therefore relieve the irritation observed.

The lenses were subsequently delivered, and within a week the patient reported inability to wear them over half an hour. She was advised to try further to establish a tolerance. At the end of two months the same situation existed, and the patient reported that she must be one of the class of patients who could not wear contact lenses.

In an effort to do everything possible to provide the patient with a comfortable lens, it was advised that she have molds made of her eyes for the newer type of lens. Molds and casts of the eyes were successfully made. Careful measurements of the casts revealed corneas 12.5 by 14.5 mm. in diameter. The reason for lack of comfort was then obvious, and molded lenses were ordered.

On arrival, the molded lenses were placed on the patient's eyes with a great deal of interest and expectation of a successful overcoming of her difficulties. Much to her satisfaction the lenses were worn for one hour, and in a reasonable length of time an actual tolerance was established.

A satisfactory fit with a ground contact lens on a patient having a wide cornea is probably due to a symmetrical flattening of the globe as it approaches the limbus. This prevents the corneal portion and the scleral section immediately about it from coming in contact with the sclera, limbus or cornea.

The second most important factor in the inability to obtain a comfortable fit with a contact lens is irregularity of curvature of the sclera. When the irregularity is symmetrical on the two sides of the horizontal meridian, it varies from just enough to cause discomfort to as much as 1 mm. or more difference in radius between axes at 90 degrees to one

Fig. 1.—Dropping of the corneal portion of a contact lens down over the cornea.

another. These differences in curvature consist mostly of short vertical radii and long horizontal radii.

Large differences in curvature are easily observed by the dropping or lateral displacement of the corneal section of the contact lens in relation to the cornea. This brings one back to pressure at the limbus, for the dropping corneal section pulls the limbus of the contact lens down on the limbus or onto the cornea itself.

Amazing amounts of scleral irregularity, however, are tolerated by patients having no pressure from the contact lens at the limbus. The irregularity is at odd points about the sclera and is not symmetrical on either side of the vertical diameter. Many slight areas of pressure are seen at the approximate insertion of the rectus muscles. If they are of sufficient magnitude to cause pressure at the limbus, they will not be tolerated.

One woman requesting a fitting of contact lenses showed a gross irregularity in the left eye and a decided but much less extensive irregularity in the right eye. As it was certain that the lens for the left eye

had to be molded in order to obtain a satisfactory fitting, the patient was advised to have lenses for both eyes molded at once. She felt, however, that satisfactory vision could be obtained with one lens only, as her refraction was —23 D. in each eye, and asked for a fitting of the right eye with the best trial lens. The fluorescein test showed considerable irregularity. The cornea was small, and no pressure was discernible at the limbus. Therefore, a trial lens was fitted for a tolerance test. Contrary to expectation, this lens was worn for over four hours with no discomfort. Because of this, a spherical lens ground to her prescription was ordered. The finished lens was worn with as much comfort as the trial lens.

In a paper on the use of contact lenses in cases of ametropia,[1] a frankly experimental technic for making casts of the human eye was suggested. The general principles involved remain somewhat the same. Numerous details are entirely different and much more satisfactory as revised. Since several papers [1a] have appeared giving two entirely different types of technic, it is hoped that a critical description and comparison of the three methods in use will serve to stimulate an interest for further research in molding processes.

Two investigators [2] have reported the use of a wax shell inserted under the lids, in much the same manner as a Müller contact lens, and left in position on the eye for ten or more minutes. The patient is instructed to move his eyes about in a normal manner, so that the wax, softening at body temperature, will take on the approximate shape of the globe influenced by the muscular play as exerted in natural movements of the eye. A glass lens is placed in the corneal section in one method. When the wax shell is judged to have assumed the natural shape of the eye being molded, ice water is poured over it to harden it sufficiently to resist a change in shape as it is being removed. A rubber sucker, such as is used for inserting and removing Zeiss contact lenses, is used to remove the shell.

The possibilities for error with this method seem obvious. The wax shell primarily will not give a detailed mold of the eye. The most that can be expected is that the general shape of the eye, limited to the high points, will be faithfully recorded. It has been claimed that details of any depressions are not desirable; whether this is so cannot be definitely stated at this time. Ice water poured over an eye will certainly cause a severe involuntary contraction of the muscles of the lids, even

1. Obrig, T. E.: Fitting of Contact Lenses for Persons with Ametropia, Arch. Ophth. **17**:1089 (June) 1937.

1a. Bruce, G. M.: Contact Glasses, Am. J. Ophth. **20**:605 (June) 1937.

2. Feinbloom, W.: A Plastic Contact Lens, Am. J. Optom. **14**:41, 1937. Prister, B.: I vetri adesivi ed il calco del segmento anteriore del bulbo, Boll. d'ocul. **12**:149, 1933.

though the conjunctiva has been thoroughly anesthetized. A distortion of the wax shell may result.

If the shell has been removed without distortion, it must then be placed in ice water, where it is constantly subject to distortion, before a casting can be made from it.

Although no change in shape may have occurred before the positive cast is made, this process, governed to some extent by the physical and chemical characteristics of the casting material, is a further possible source of distortion.

The method for molding used at the Institute of Ophthalmology of the Presbyterian Hospital in New York was devised to obtain records of the corneas in cases of keratoconus and is efficient for that purpose.[3] No record of the scleral curvature was desired or attempted.

The procedure calls for the use of a speculum to hold the lids apart. An aluminum dam open at both ends is placed in contact with the sclera so that it surrounds the cornea. Liquid negocoll is poured into it and allowed to gel. The dam and negocoll together are then removed from the eye, and a positive plaster cast is made from the negative so formed.

The criticism of this method of molding for contact lenses is that there is a possibility of a distortion of the scleral surface due to pressure brought to bear by the narrow bearing surface of the circumference of the aluminum dam. Further, there is a lack of opportunity to obtain sufficient scleral surface to be of use in molding contact lenses. The speculum prevents large enough dams to be used to obtain a wide scleral band about the limbus.

The method now used is directly a result of independent investigation and experiment by Dr. D. B. Kirby and myself, except for employment of a molding shell with a handle. The evolution of this device will be given later. This method of making molds of the living eye has several important advantages. First, considerable scleral surface can be molded about the cornea. The limit of the area obtained is governed by the size of the palpebral opening, the looseness of the lids, the size of the globe and the position of the eye in the orbit.

Various-sized shells may be employed, and contact lenses of varying sizes may be made from the molds obtained. It is obvious that an eye with a small palpebral opening and a deep-set globe will not require as large a finished lens as an eye which shows a moderate degree of exophthalmos. The size of the molding shell which may be used successfully will mold sufficient scleral area to produce a finished molded lens of proper dimensions for each patient.

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3. Stevens, C. L.: Method for Making Casts of the Human Cornea, Am. J. Ophth. **19**:593 (July) 1936.

Second, pressure on the globe is distributed evenly over a large area, with little, if any, pressure on the sclera from the rim of the molding shell. This condition minimizes distortion of the sclera by the casting shell itself. Corneal distortion does occur at times because of the more resilient quality of the corneal tissue. Such an irregularity, which is mostly confined to the apex of the cornea, is of no importance, because with the new technic the corneal section of the cast is not used. The scleral curvature and the outline of the limbus are the details desired from the casting.

Third, extremely fine detail results with the negocoll and casting shell procedure. Every scleral irregularity is truly reproduced in the finished casting.

Fig. 2.—Equipment for making castings.

Fourth, the negocoll mold, being backed up by the rigid glass casting shell, prevents any chance of distortion of the mold before the cast is poured.

Fifth, the time factor is important. With proper preparation, the physician need spend little time with the patient. The whole procedure need not take more than fifteen or twenty minutes.

EQUIPMENT NEEDED

The equipment necessary for making a finished cast consists of:

1. A set of Zeiss afocal trial contact lenses
2. Poller's negocoll
3. A double boiler

4. An electric or gas stove or a sterilizer
5. Two 50 cc. pyrex beakers
6. One 250 cc. beaker
7. An Eastman kodak stirring thermometer
8. Molding shells of various sizes
9. A stainless steel spatula
10. Demitasse spoon
11. Cotton
12. Gauze pads
13. Absorbent tissue
14. Cotton-tipped toothpicks
15. A modern local anesthetic
16. Epinephrine hydrochloride
17. Several small narrow-mouthed bottles
18. A small plaster bowl
19. French's regular dental plaster or albastone
20. Half-normal solution of sodium chloride or Ringer's solution
21. Undine or syringe for washing out eyes
22. A muscle hook

THE MOLDING SHELL

The first castings were made with the aid of Müller lenses, the technic being that of Dr. D. B. Kirby, as reported in the ARCHIVES OF OPHTHALMOLOGY.[1] Shortly after this procedure was successfully used, it was brought to the attention of Dr. Harry Eggers. He suggested that a Müller lens with some sort of a handle would be a distinct advantage over the ordinary Müller lens. With this thought in mind, I began experimenting with various designs of casting shells, with the assistance of Mager and Gougelman, manufacturers of glass eyes. One of these shells was described in the aforementioned report, in which the technic employing the Müller lens-molding shell was given. This shell, while being an advance, had several disadvantages.

The present solution of the problem of the casting shell consists of making the shells oval and 22 by 24 mm., 23 by 25 mm. and 24 by 26 mm. in size (fig. 3). The long sides are arched in much the same manner as an eye cup. The depth of the shell from the lowest portion of this arch to the integral hollow handle is about 7 mm. The handle is 25 mm. long, hollow and tapering slightly to a sealed far end. One of the long ends of the shell is marked with a red line to indicate the position of the right nasal side (red for right), and any other colored line is used for the shell applied to the left eye. These shells give sufficient scleral coverage and are easily inserted beneath the lids. The nasal markings are simple to place in the proper position. They are comparatively easy to remove intact with the negative negocoll mold.

NEGOCOLL AND ITS PREPARATION

Poller's negocoll has proved satisfactory in use. The number of my moldings amounts to well over 400. In no case has any injury or destruction of corneal epithelium taken place, except to the most negligible extent, and that did not cause the patient any distress or discomfort.

The manufacturers suggest that negocoll be prepared in nickel or enamelware utensils and not in aluminum, which metal has an undesirable effect on the negocoll, reducing materially the number of times it may be used. It seems unwise to use enamelware for ocular work because of the possibility of chipping and of resulting corneal injury should a chip be included in the negocoll placed on the eye. Nickel utensils are difficult to obtain, and the solution of this problem may be the use of pyrex glass or porcelain. Regardless of the manufacturer's caution, I have used an aluminum double boiler in all my work.

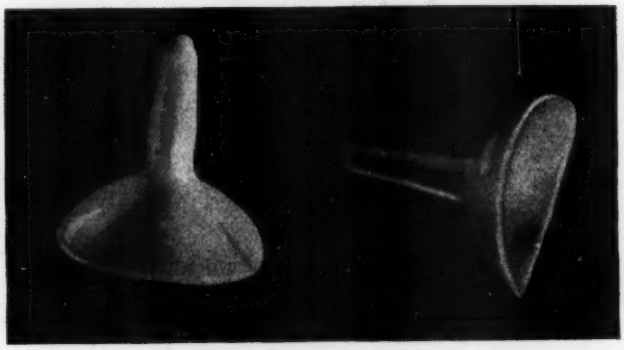

Fig. 3.—Molding shells.

To prepare negocoll for use, several ounces of the material is placed in the upper part of a double boiler, together with as much warm water as it will absorb. Any surplus water is poured off, and the wet mass is boiled until it becomes a homogeneous semiliquid. Prolonged boiling does not seem to affect its gelling qualities; it tends rather to produce a more even, lumpless mixture. A lid should be kept on the boiler to prevent undue evaporation of the water content. The exact consistency best adapted to the individual physician can be determined best by experiment. Generally, it may be stated that the thicker the mixture the quicker the gelling and the higher the temperature at which it will gel. However, no matter how liquid it may be at temperatures over 100 F., it will always gel at body temperature. When the mixture is at 150 F., it should be as liquid as a heavy cream for best results. As it is cooled, a thickening will take place, until at 104 F. it may best be described as of the consistency of warm molasses. In mold-

ing, a small portion of the negocoll should be transferred to a 50 cc. beaker for cooling and the main portion kept hot.

DETAILED PROCEDURE FOR FITTING MOLDED LENSES

The patient is fitted with the best fitting afocal trial contact lens. Care must be taken to clear the cornea with the corneal portion of the lens and to see that there is as little pressure at the limbus as possible. The least pressure at the limbus can be assured by fitting a trial lens which is slightly tight at the scleral rim. Such a lens, besides clearing the limbus, will be most easily removed. The fit of the scleral portion is not important, as the cast will take the place of this measurement when the finished lens is ordered.

With the chosen contact lenses in place, refraction is done with care. Only spherical corrections can be ground on the contact lens, and therefore the best spherical correction used in conjunction with the trial contact lens is recorded. Any manifest astigmatism is lenticular and cannot be corrected. It is usual to find from plus or minus 0.25 D. to plus or minus 1.25 D. of lenticular astigmatism in about 5 per cent of the patients fitted.

The vertex distance of the refracting lenses, that is, the distance between the posterior surface of the refracting lens and the anterior surface of the contact lens, must be carefully measured and noted on the prescription.

The corneal curves of the contact lenses are recorded also, and the complete prescription will read something like:

O.D. —7.00 D. at 10 mm. V.D. with 8 mm. corneal curve
O.S. —6.00 D. at 10 mm. V.D. with 8 mm. corneal curve

As soon as the data concerned with the refraction are recorded, the contact lenses are removed, and the patient is prepared for the molding.

PREPARATION OF PATIENT FOR MOLDING

For a rapid successful molding, the patient should be prepared both mentally and physically to insure his active cooperation.

In order to still his imagination, the entire procedure should be described to him in a few words. As trial lenses have already been applied and because that procedure is always much less distressing than the patient imagines, he should be told that the taking of a mold is no more disagreeable than the insertion of a contact lens.

It should be forcefully stated that the successful completion of the molding depends on his cooperation, principally in three ways: First, he must keep the eye not worked on open and gazing at a point predetermined to center the cornea properly. Second, he must keep his eyes quiet and fixed on this point for the first two minutes at least.

Lastly, he must move his eyes as directed while the mold is being removed and not become anxious if considerable time is taken in doing so. In 1 unusual case nine minutes was required to remove the casting shell with the negocoll mold intact. On the average, this procedure requires only two or three minutes.

The patient should have a thorough conjunctival anesthetization with any of the modern local anesthetics. With the last drop, just before the molding shell is placed on the eye, 1 drop of epinephrine hydrochloride will help to prevent undue congestion.

CONSTRUCTION OF THE MOLD

The patient is placed on his back and made comfortable. A careful check of the position of the eyes must be made at this time. A slightly upward positioning of the cornea is to be preferred. An additional drop of anesthetic and a drop of epinephrine hydrochloride are given to insure a painless molding, free from congestion.

The nurse should have prepared the negocoll, as previously described, while refraction was being done. From the double boiler, she now places about 20 cc. of the hot negocoll in a 50 cc. pyrex beaker, stirring it gently with a stirring thermometer, with which the temperature of the mixture is carefully watched. A beating motion should not be used, as this will separate the cotton fiber contained in the negocoll in such a way that it will collect about the shaft of the thermometer.

A piece of absorbent cotton is firmly forced into the hollow handle of the molding shell and slightly tufted out at the top. This is done to help bind the negocoll mold to the casting shell and prevent the separation of the two when they are being removed from the eye.

When the negocoll cools to 105 or 104 F., the physician completely fills a molding shell from the beaker with a spatula or a demitasse spoon or by pouring directly from the beaker. The shell is held hollow side up until it is over the patient's eye. The upper lid is pulled well back; the shell is inverted and, with the nasal marking placed toward the nose, is inserted under the lid. An assistant immediately retracts the lower lid, and the shell and negocoll are lowered onto the globe with as little vertical or horizontal movement as possible, to prevent conjunctival folds.

Considerable negocoll will have been forced from under the shell over the eyelids. No attempt should be made to wipe this excess away. The negocoll should be allowed to gel in position, as it will help to keep the eye centered by binding the lids to the shell. It is easily removed with a muscle hook when solid.

During the foregoing procedure it is absolutely necessary that the patient keep the eye not worked on open and fixed on the ceiling

marker. Dr. Kirby suggested that in cases of aphakia or of high myopia the patient's prescription lenses may be held over the open eye to assist him. If the eye not worked on is closed, both eyes have a tendency to roll upward. This results in an upward displacement of the corneal position in the finished mold. If necessary, the upper eyelid can be held open to prevent closing for the first two minutes the casting shell is on the other eye.

The negocoll and shell are left untouched for a five minute setting period, after which the excess negocoll is easily loosened from the margins of the lids with a muscle hook. The patient is then instructed to look down, and the upper lid is retracted so that the upper edges of the negocoll mold may be seen. If this extends upward to some extent beyond the molding shell, it is carefully loosened with the aid of a muscle hook as the casting shell is gently pressed downward by the handle, with one finger of the hand holding up the lid. The patient is then instructed to look up, and the lower margin of the negocoll mold

Fig. 4.—Negative negocoll mold.

is loosened in the same manner. The nasal and temporal portions are inspected next. Finally, the entire casting shell is given alternate vertical and horizontal movements to break up the adhesion over the cornea, where considerable suction often tends to hold the mold to the eye. If any difficulty is experienced in breaking this suction, the rounded edge of a muscle hook can be carefully placed under the shell at the nasal or temporal end, and with gentle upward pressure the entire shell and negocoll can be raised slightly to let in some air. Once air enters beneath the mold, it will come away easily. If the greater part of the overflow of negocoll is beneath the lower lid, the shell is removed with the upper lid retracted. If the greater mass is under the upper lid, the lower lid is retracted when the mold is removed.

If an unsatisfactory centering of the corneal portion results, a mold should be made of the other eye, and when this is completed a second mold should be made of the first eye. Several patients have had three moldings of each eye during the same afternoon, with no ill effects. One should be guided by the amount of visible inflammation, however, in each individual case.

Any visible chemosis is a contraindication to further molding, as it is impossible to obtain the true scleral curvature when any edema is present. The ideal mold will produce slightly more scleral area below the cornea than above it.

As soon as satisfactory molds are made, the patient's eyes should be well examined for loose pieces of negocoll. These are particularly likely to remain under the upper lid, high up, and often extend horizontally entirely across the fornix.

Immediately on removal, the mold should be placed in cold water while a mold of the second eye is being made. After the second mold is well chilled, all excess water is shaken from the mold and the surface partially dried with a cotton ball. The molding shells are then placed handle down in a pair of small narrow-mouthed bottles. French's regular dental plaster or some good dental stone is prepared in a small

Fig. 5.—Shell with negocoll mold and plaster cast in bottle.

soft rubber plaster bowl and well spatulated to remove bubbles. The bowl is pinched to form a spout, and the plaster is poured into the molds from one side while liquid to prevent the formation of air pockets. One should not wait for the plaster to thicken before pouring it.

The mold and cast should not be touched for half an hour. At the end of that time a line should be drawn across the cast from the inner to the outer canthus. With the shell held as it would be if removed from one's own eye, L or R is marked above the horizontal line to indicate whether the cast is for the right or the left eye; then an N is marked to the nasal side and a T to the temporal side of the R or L. Under the horizontal line, the patient's name is engraved. The markings then appear thus:

N R T
Jones

After the castings are marked, they are left to harden for another hour. At the end of this time the cast and negocoll are removed together from the casting shell. A small knife is run about the edge of the shell to cut away any plaster which has run over the sides.

A small spoon spatula, such as is used for removing wax from the ear, is worked between the negocoll and the plaster cast at the nasal or temporal side and then gently run about the entire circumference of the casting to loosen the negocoll from it. As soon as the edges are free, the negocoll and the casting separate easily. If the cast and negocoll have been left standing so long that difficulty is experienced in separating them, they should be soaked in warm water for half an hour.

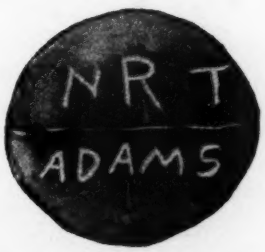

Fig. 6.—Cast showing markings on the back.

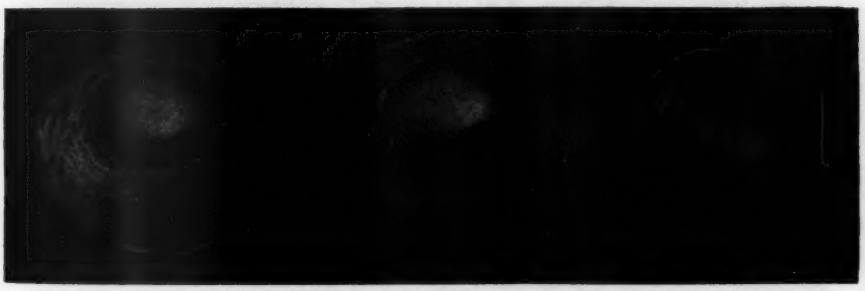

Fig. 7.—Three plaster casts of eyes.

A second casting should be retained by the ophthalmologist for checking or for use in case any accident may happen to the casting supplied the Zeiss Company. While it is possible to make a second casting from the original mold if it has been removed carefully, after it has stood in cool water for a while the accuracy of the second cast is open to question. Some drying of the original negocoll mold will have taken place, and the soaking in cool water will replace this loss. However, to what extent this takes place has not been determined.

With no special preparation, 40 patients have been fitted with molded contact lenses in one visit. The entire procedure was completed in from one to one and a half hours. In these cases I inserted

the trial contact lenses, prepared the negocoll and did the actual molding and the pouring of the casts. The physician made a general preliminary examination, refracted the eyes with the trial lenses in place, checked the corneal clearance with a slit lamp and assisted in the inserting and removing of the molding shells.

In view of the time taken in fitting ground contact lenses, which often requires from six to ten visits, it is evident that much time and effort can be saved by prescribing molded contact lenses. There are times when a satisfactory mold is not obtained during the first visit, and in these instances the patient must return for a remolding. Experience has taught that with adequate cooperation from the patient such cases decrease in number as one becomes familiar with the process of molding.

THE FINISHED LENSES

The finished lenses, as supplied by Carl Zeiss, are oval and of the general dimensions called for when ordered. The anterior surface of

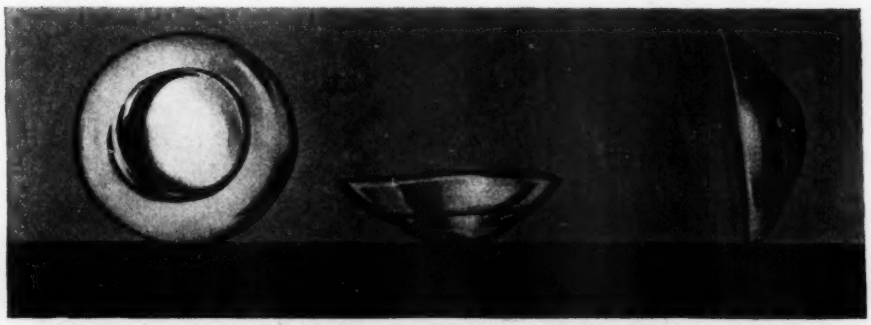

Fig. 8.—Finished molded contact lenses.

the scleral portion appears uneven, with much the same appearance as the scleral portion of the cast. This unevenness in surface tends to make the finished lens better tolerated, as it fits in what may be called "spot contact" on the sclera instead of over a continual even surface, as is seen with the ground lens. This is an advantage in that the blood supply of the anterior fifth of the globe is less disturbed and the nutrition of the cornea, therefore, less affected. Further, the flow of the tears under the contact lens is facilitated, thus shortening the time necessary to replace the fluid used when inserting the lens. The accumulation of oil, principally from the upper lid, under the corneal portion of the contact lens is also minimized by the increased flow of lacrimal fluid under the lens.

The corneal portion of the molded lens is ground and polished to prescription with the care and accuracy expected for an ophthalmic lens of first quality. In fact, the corneal portion is identical to that

supplied in the ground type of contact lens, with which ophthalmologists have been familiar for a number of years.

In all molded lenses recently received, allowance for the width of the patient's cornea has been made by molding a third curve nasally and temporally adjacent to the corneal portion proper. This type of grinding has proved to be the solution of the problem of the wide cornea.

The science of haptics,[4] which has to do generally with touch, and in regard to contact lenses with the bearing of the surface of the con-

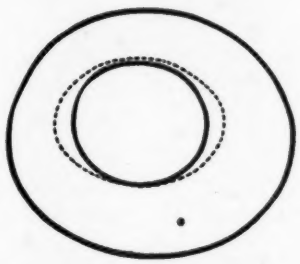

Fig. 9.—Ideal position for the corneal portion of a contact lens.

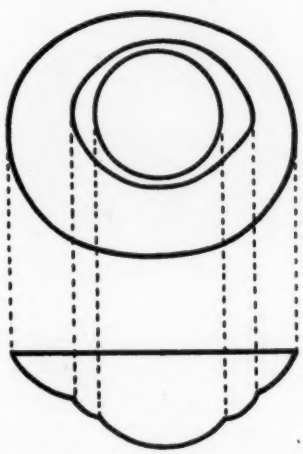

Fig. 10.—Molded contact lens with molded area about the ground corneal portion to take care of a wide cornea.

tact lens against the conjunctiva, is used in a most delicate manner in altering to some extent the actual scleral surface supplied by the casting before a contact lens is molded from it. Experience with contact lenses forces one to realize that the fit of any contact lens should be slightly loose, principally near the insertion of the rectus muscles. When one

4. Thier, P. F. X.: Haptik von Kontaktgläsern, Klin. Monatsbl. f. Augenh. **96**:542 (April) 1936.

is fitting the ordinary ground Zeiss contact lens, the tightness caused by muscular movement is easily observed over the relaxed muscle rather than over the active muscle during ocular movements; with a well fitted scleral portion on the eye, when the eye is moved temporally a tightness is seen near the insertion of the internal rectus muscle. When the eye is rotated slowly nasalward, this tension is observed to decrease gradually until it is no longer present. This same type of tightness is often seen templeward, when the eye is moved nasally. On eyes with practically spherical scleras, tightness is often observed near the inferior rectus muscle as the eye is moved upward. However, the horizontal movement seems to be the principal cause for concern.

Care must always be taken that the lower scleral flange of the contact lens is not loose enough to extend away from the sclera, because the lower lid is likely to catch under it and force the lens from the eye, or in any case to prevent the lower lid from sliding up over the contact lens. If it is desirable to make the lower flange of the lens fit loosely for any reason, it should be made deep enough to avoid any possible contact with the margin of the lower lid.

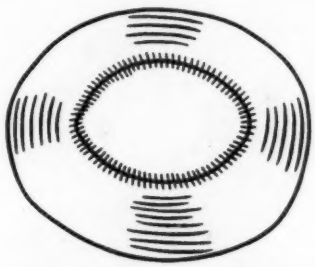

Fig. 11.—Mold demonstrating the need of building up to clear the limbus and allow for muscular play. The shaded areas indicate the portions to be built up.

The upper portion of the scleral band of the contact lens presents the least difficulty. It does not seem to need as much bearing surface as the three other portions. It presents little, if any, indication of tightness when the eyes are directed downward if the scleral portion is well fitted.

In view of the foregoing observations, it seems logical that a satisfactory fit of the scleral portion will result in a molded contact lens if the bearing surface is slightly tighter at the four points formed by two crossed lines at 45 and 135 degrees to the horizontal, favored nasally above and templeward below to neutralize the slight torque caused by the movement of the lids.

The only requirement of the corneal portion besides giving adequate vision is a positive clearance of the limbus. Carl Zeiss has apparently solved the problem of pressure at the limbus in the molded lens by the extra horizontal molding at the nasal and temporal sides of the corneal

section, which can be obtained by building up on the original cast for a distance of 1 mm. inside and outside of the sulcus.

INSTRUCTIONS FOR ORDERING LENSES

When the finished lenses are ordered, the casts are sent to provide the scleral curvature and the size of the corneas.

The refraction with the trial lenses in place gives the information necessary to grind the corneal portion of each lens. Three elements must be stated here: the corneal curve of the contact lens used, the added correction necessary and the vertex distance of the refracting lens from the corneal portion of the contact lens.

The size of the lens required must be stated and may be varied to meet individual needs: 20 by 21 mm. for eyes of average size; 19 by 20 mm. for small eyes, and 21 by 22 or 22 by 23 mm. for large protruding eyes.

An example of an adequate order, with instructions for marking the lenses and the casts, follows:

One pair of molded contact lenses as prescribed from the casts supplied. Lenses to be made 20 by 21 mm.

O.D. —7.00 at 10 mm. V.D. with an 8 mm. corneal curve
O.S. —6.00 at 10 mm. V.D. with an 8 mm. corneal curve

Mark lenses with an engraved line at the nasal sides and the left lens with an L. Casts marked:

$\frac{\text{T L N}}{\text{Jones}}$ $\frac{\text{N R T}}{\text{Jones}}$

FITTING THE FINISHED LENSES [5]

Before the finished contact lenses are delivered to the patient, he must be taught to insert them and remove them with ease. A satisfactory solution must also be prescribed for use with the lenses. Transient corneal opacities and clouding of the corneal liquid lens formed between the contact lens and the cornea, with the resulting rainbow colors often complained of, have proved difficult to overcome.

A study of the causes of these difficulties has made it possible to minimize their effect to a negligible amount. The chemical composition, density, p_H and refractive index of the solution are all concerned.

A solution with chemical and physical characteristics similar to each individual lacrimal fluid will not cause opacities. Physiologic solution of sodium chloride is the least satisfactory of those tried and should not be used.

Clouding of the fluid lens over the cornea is due primarily to a collection of the oily secretion from the sebaceous glands of the lids.

5. Obrig, T. E.: Recent Advances in the Technic of Fitting Contact Lenses, Guildcraft **11**:33, 1937.

To a lesser degree, clouding is due to mucus in solution or in strands which work their way under the corneal portion of the contact lens.

Dr. Kirby has suggested that clouding can be minimized by instructing the patient to massage the lids at the lashes, using a piece of gauze or linen over the index finger. With a horizontal movement above and over the lashes, the sebaceous material is expressed from the glands. This procedure is followed with a thorough washing of the eyes, an eye cup being used, to remove the expressed oil and any mucus present. The solution used with the contact lens to form the liquid lens can be employed satisfactorily for this purpose.

After considerable experimenting and the trial of a number of solutions, the most satisfactory one has been found to be a sodium borate-boric acid buffer solution, as suggested by Feldman,[6] made to the approximate p_H of the patient's lacrimal fluid as found mixed with the normal mucus on the lower eyelids.

A satisfactory determination of the approximate p_H can be obtained with nitrazine paper rubbed on the lower lids near the inner canthi. This test paper changes color and is compared with a color chart supplied. Estimates between the p_H color changes indicated may easily be made. If the test paper turns bluer than the chart color which indicates p_H 7 and still not dark enough to match that for p_H 7.5, an estimate of p_H 7.2 may be made. A color darker than that which indicates p_H 7.5 may be estimated as p_H 7.8.

To prepare the buffer solution in varying p_H intervals, two parent solutions are prepared according to the following formulas and combined as indicated. The refractive index of these solutions is approximately 1.335, which is satisfactory.

Solution 1	
Sodium borate	19.108 Gm.
Distilled water	1,000.000 cc.
Solution 2	
Boric acid	12.404 Gm.
Sodium chloride	2.925 Gm.
Distilled water	1,000.000 cc.

To obtain the various p_H values, the two solutions are mixed in the following proportions:

p_H	Sodium Borate, Cc.	Boric Acid Solution, Cc.
7.0	0.95	9.05
7.2	1.0	8.5
7.5	1.5	8.0
7.8	2.0	7.5
8.0	2.6	6.9

6. Feldman, J. B.: p_H and Buffers in Relation to Ophthalmology. Arch. Ophth. **17**:797 (May) 1937.

INSTRUCTIONS TO PATIENT

The patient will be able to insert and remove the contact lenses easily if the following instructions are given.

Insertion.—Massage the eyelids at the eyelashes with a piece of gauze to remove oil from the glands on the lids. Use horizontal movement.

Wash the eyes with an eye wash to remove all oil.

Warm the solution used with the contact lens.

Place the contact lens, well centered, on a rubber sucker.

Fill the contact lens with the warm solution.

Raise the upper lid with the fingers over the lashes.

Keep the eye fixed on the hole in the sucker, and place the lens against the eyeball and over the lower lid.

Release the upper lid.

Keep firm gentle pressure against the eye.

Push the lens upward slightly toward the eyebrow and at the same time pull the lower lid well down.

The glass will then jump over the margin of the lower lid onto the eyeball.

Release the lower eyelid.

Press on the sucker to remove suction, and remove the sucker sideways.

Wipe excess liquid from the lids.

Removal.—Separate the eyelids with the fingers over the lashes.

Look directly at the hole in the sucker.

Press the sucker bulb.

Place the sucker firmly against the center of the contact lens.

Release the sucker bulb to obtain suction.

Pull the lens down and out from the eye.

Do not move the eyes around. Keep the vision fixed on the hole in the sucker when inserting and removing contact lenses.

FURTHER PROBLEMS

Two important problems requiring careful investigation and research must still be solved in order to obtain maximum comfort with the satisfactory contact lenses available today. First, a better buffer solution, more nearly identical with the lacrimal fluid and still flexible enough to be prepared in varying p_H intervals, is essential. Second, some form of treatment must be devised to toughen sensitive conjunctivas which will not tolerate contact lenses no matter how good the fit. This seems to call for a properly buffered astringent combined with a suitable anesthetic stable in an alkaline solution to enable the patient to bear the irritation of the astringent, which can be built up in strength as it becomes tolerated.

It is my sincere hope that the detail presented here will be of assistance to all those desiring to work with contact lenses, and still more important, that it will be a stimulus to further investigation, resulting in refinements and better methods of obtaining molds of the living eye. Any suggestions will be appreciated.

REPORT OF CASES

Case 22.—Mr. B. S. on refraction showed vision of 15/30 in the right eye with a —8.00 D. sph. ⌒ + 9.50 D. cyl., axis 125 (without lenses, 15/100) and of 15/30 in the left eye with a —8.50 D. sph. ⌒ + 9.50 D. cyl., axis 65 (without lenses, 15/100). He was fitted with Zeiss ground trial contact lenses, a lens 12.5/7.5, with —1.25 D. added power, being used in the right eye and one 12.5/7.5 being used in the left eye. Vision in the right eye was 20/20, and although that in the left eye was not recorded it was not as good.

The trial lens showed a decided irregularity in the scleral portion, with tightness horizontally and a dropping of the corneal portion of the contact lens. The limbus of the corneal portion of the trial lens also seemed to fall inside the limbus of the cornea. This fact was verified by the corneal size as measured from the casting, which was 12 by 14.5 mm.

A mold was made at once of the right eye alone, because the patient wanted only one contact lens. The casting was sent to Carl Zeiss, with instructions to make the lens 20 by 21 mm.

The finished lens was received in three months. The fit of the scleral portion was excellent, and the visual acuity was 20/15. The patient was taught to insert and remove the lenses in one-half hour.

The p_H of the patient's lacrimal fluid as determined with nitrazine paper was 7.8. A boric acid-sodium borate buffer solution of this value was prescribed.

At the end of one week the patient reported that he had worn the lens two and a half, three, four, five, six and nine hours on succeeding days. He stated that the eye was sore the first few days but that the irritation gradually decreased each day.

Two weeks later the patient reported that the lens was satisfactory and had been worn from three to seven hours each day during the past two weeks.

Case 1.—Miss V. B. on refraction showed vision in the right eye of 20/30 with a + 8.50 D. sph. and in the left eye of 20/20 with a + 8.00 D. sph. She was fitted with Zeiss ground trial contact lenses, a lens 12.5/7.5, with +1.75 D. added power, being used in the right eye and one 12.75/7.5, with + 1.50 D. added power, being used in the left eye. Vision in the right eye was 20/30 and in the left eye, 20/20.

The right trial lens showed a decided tightness horizontally combined with a looseness vertically, with a dropping down of the corneal section of the contact lens.

The left trial lens was a fair fit but looked small on the eye and had a tendency to catch on the lower lid. The eyes appeared larger and more protruding than the average, and the palpebral openings appeared wider. Careful measurement of the corneas with a ruler gave a horizontal width of 13 mm., which on the basis of my experience with castings was considered 20 per cent under actual measurements. This fact was verified later by the castings made, on which the corneas were measured as 13.5 by 15 mm.

In view of the irregular scleral curve of the right eye, the position of the eye in the orbit, the large palpebral opening and the large cornea, molds of each eye were made. Satisfactory casts were obtained with the first molding, and these were sent to Carl Zeiss, with instructions to make the lenses 22 by 24 mm. in size.

The finished lenses were received in four months and proved to fit perfectly in the scleral portion.

The vision obtained was also satisfactory, showing on test 20/30 in the right eye and 20/20 in the left eye, as with the trial lenses. The lenses were worn for two hours, with no irritation at this time.

The p_H of the patient's lacrimal fluid as determined with nitrazine paper was p_H 7.5. A sodium borate-boric acid buffer solution of this value was prescribed.

At the end of one week the patient reported that the contact lenses had been worn for several hours each day, but that she had cracked the right lens cleaning it and was no longer able to try to establish a tolerance. A new lens was ordered to replace the cracked one.

CASE 3.—Miss M. B. on refraction showed vision of 20/40 in the right eye with a —5.00 D. sph. and of 20/20 in the left eye with a —5.50 D. sph. She was fitted with Zeiss ground trial contact lenses, a lens 12/8, with —3.25 D. added power at 12.5 mm. vertex distance, being used in the right eye and one 12/8, with —3.25 D. added power at 12.5 mm. vertex distance, being used in the left eye. Vision in both eyes was 20/30 +.

Each trial lens showed an irregularity in the scleral portion, with tightness horizontally combined with a looseness vertically. The corneas as measured with a ruler were a short 12 mm. The castings proved the corneal measurements to be 11.5 by 13 mm. in the right eye and 12 by 14 mm. in the left eye.

Moldings were made at once and proved satisfactory on the first trial. The plaster casts were sent to Carl Zeiss, with instructions to make the lenses 20 by 21 mm.

The finished lenses were delivered in four months. The fit of the scleral portion was perfect, and the visual acuity was 20/20 in each eye and 20/15 with both eyes. The patient wore the lenses for three hours at this time and reported that they felt better before removal than when they were originally put on.

The p_H of the patient's lacrimal fluid as determined with nitrazine paper was about 7.6. A sodium borate-boric acid buffer solution with p_H 7.5 was prescribed.

At the end of one week the patient reported that she had worn the lenses for three hours every day and had no opportunity to wear them longer at this time. A slight smarting was noticed the first two days but was not felt after this time. No irritation was present when the lenses were removed.

At the end of the second week the patient reported that the lenses were worn with comfort for from three and a half to four hours at a time and by the end of the week for two four hour periods a day. No irritation was present when they were removed. The only trouble experienced was some clouding after four hours of wearing. This was due to dissolved mucus and sebaceous material and not to any clouding of the cornea, as vision was clear immediately on the removal of the contact lenses.

At the end of a month and a half the patient reported that the lenses were well tolerated and said: "They seem to fit beautifully and I am very pleased with them."

CASE 10.—Mrs. E. H. on refraction showed vision of 20/25 in the right eye (aphakia) with a + 12.00 D. sph. and of 20/20 in the left eye with a plano lens. The right eye was fitted with a Zeiss ground trial contact lens 12.75/7, with + 9 D. added power at 10 mm. vertex distance, vision being 20/20.

The trial lens showed a decided irregularity in the scleral portion, with tightness horizontally, and a satisfactory mold was made at once.

The corneal measurement from the cast was 12 by 13 mm.

The casting was sent to Carl Zeiss, with instructions to make the lens 20 by 21 mm. in size.

The finished lens was returned in five months and presented a satisfactory fit in the scleral portion, with vision of 20/30 +.

The p_H of the lacrimal fluid as determined with nitrazine paper was 7.5, and a sodium borate-boric acid buffer solution of this value was prescribed.

It had been thought that with the ametropia corrected by a contact lens, the aniseikonia induced by monocular aphakia might be corrected more easily with iseikonic lenses. This, however, does not seem probable.

Case 19.—Miss E. P. on refraction showed vision of 20/20 in the right eye with a —5.00 D. sph. and of 20/20 in the left eye with a —5.00 D. sph. She was fitted with Zeiss trial contact lenses, a lens 12.5/8, with —5.00 D. sph. added power at 13 mm. vertex distance, being used in the right eye and one 12.75/8, with —5.00 D. sph. added power at 13 mm. vertex distance, being used in the left eye. Vision was 20/15 in each eye.

The trial lens for the right eye showed a slight irregularity of the scleral portion, with looseness temporally. That for the left eye showed a decided irregularity of the sclera portion, with tightness vertically. The corneas seemed larger than the corneal portions of the contact lenses.

Molds were successfully made during the second visit and were sent to Carl Zeiss, with instructions to make the lenses 20 by 21 mm. The sizes of the corneas as measured from the casts were 12 by 13.5 mm. for the right eye and 12 by 13.75 mm. for the left eye.

The finished lenses were received in four months and showed an excellent fit in the scleral portion, with vision of 20/15 in each eye. The lenses were worn for two hours the day they were received.

The p_H of the patient's lacrimal fluid as determined with nitrazine paper was 7.5. A sodium borate-boric acid buffer solution of this value was prescribed.

At the end of a week the patient reported that the lenses were worn from one half to three quarters of an hour several times during the week and were not used every day. The right lens felt much better than the left one each time they were worn.

At the end of the second week she reported that the lenses were worn only three quarters of an hour each evening. The right lens gave no trouble, but the left caused a burning sensation at the end of this time.

The patient was asked to call for observation. The fit of the scleral portion was excellent, but on retaking the p_H of the lacrimal fluid a reading of p_H 7.8 was obtained instead of p_H 7.5 as previously determined. A new prescription for a sodium borate-boric acid buffer of this strength was given. As a further experiment, a prescription for a sodium carbonate-boric acid buffer (Gifford) [7] p_H 7.8 was given. At the end of another week the patient reported that both 7.8 buffers were decidedly better than the first solution prescribed and that she was able to wear the lenses from two to three hours. She felt much encouraged and promised to continue to establish a tolerance.

Case 18.—Miss N. K. on refraction showed vision of 20/50 in the right eye with a —6.00 D. cyl., axis 20 and of 20/50 in the left eye with a + 1.50 D. sph. ⌢ —6.00 D. cyl., axis 150. She was fitted with Zeiss trial contact lenses, a lens 13/7.5, with —2.00 D. added power, being used in the right eye and one 13/7.5, with no added power, being used in the left eye. Vision was 20/40 in the right eye and 20/20 in the left eye.

The trial lenses showed the greatest irregularity of the sclera so far encountered, approximately 2 mm. difference in radius of curvature between the horizontal

7. Gifford, S. R.: Reaction of Buffer Solution and of Ophthalmic Drugs, Arch. Ophth. **13**:78 (Jan.) 1935.

and the vertical radius. The vertical radius was the shorter, and the best fitting trial lenses were tight horizontally. The patient had a mild keratoconus and could not be given vision of over 20/50 with ordinary spectacle lenses.

Molds were immediately and satisfactorily made during the first visit, and the castings were sent to Carl Zeiss, with instructions to make the lenses 20 by 21 mm. The corneal measurements from the casts were 12 by 13 mm. for the right eye and 12 by 12.5 mm. for the left eye.

The finished lenses were received in four months. The great difference in the curvature of the two meridians was apparent in the lenses before they were placed on the eyes. A satisfactory fit of the scleral portion was obtained, and the visual acuity was the same as with the trial lenses. With a —1.50 D. cylinder before the right contact lens, the visual acuity was raised to 20/30 +, indicating a considerable amount of lenticular astigmatism. The patient wore the lenses for two hours the day they were delivered. A mild congestion was present when they were removed.

The p_H of the lacrimal fluid as determined with nitrazine paper was 7.5. A sodium borate-boric acid buffer solution of this value was prescribed.

At the end of three weeks the patient reported that she could not wear the lenses longer than two or three hours at a time. A new buffer solution, of p_H 7.8, was prescribed. She reported less smarting with this solution and is still trying to establish a tolerance.

CONCLUSIONS

The principal difficulty in securing comfort with contact lenses is due to pressure at the limbus, horizontally.

Corneal measurements are difficult to take from the eye itself.

Corneal measurements are most accurately and easily measured from a cast of the anterior portion of the eye.

Corneal measurements so taken are considerably larger than generally believed, averaging 12 by 13.5 mm.; 74 per cent of those measured are from 13 to 14 mm. horizontally; 65 per cent, from 12 to 12.5 mm. vertically. Ten corneas measured 15 mm. in width.

Irregularity of the scleral portion is the second most important difficulty in securing comfort with contact lenses.

Such an irregularity causes discomfort by pulling the contact lens against the limbus, thus resulting in pressure at the limbus.

Negocoll has proved a harmless, satisfactory substance with which to mold the eye.

A satisfactory molding shell has been developed in various sizes to meet individual requirements.

The molding process using negocoll and a special molding shell is the most satisfactory method of making a cast of the anterior portion of the eye.

This method has produced no corneal injuries in over 400 moldings.

Three molds have been made from an eye during the same afternoon, with no ill effects.

The entire procedure of fitting molded contact lenses has been done during one visit of an hour and a half with 40 patients.

The new molded lens made from a casting of the anterior portion of the eye is more satisfactory than a ground lens, because it is molded and ground to avoid pressure at the limbus as well as to give a good fit in the scleral portion.

Measurements of the curve of the sclera and the size of the cornea for molded lenses are obtained from the cast.

Instructions for grinding the corneal portion are obtained by a visual manifest with the best fitting corneal portion of a trial aspherical contact lens plus the added refraction required. The corneal curve of the trial lens, the added refraction and the vertex distance between the contact lens and the refracting lenses are all stated when the finished lenses are ordered.

A sodium borate-boric acid buffer solution made up to the p_H of the patient's lacrimal fluid is most satisfactory to use as the fluid lens.

Not all patients can wear the most perfect fitting contact lenses for periods over two hours, even though they clear the cornea and limbus and conform to the irregularities of the sclera. More research must be carried out to determine the reason for the establishment of tolerance with some eyes and the cause of various degrees of intolerance of other eyes.

STRENGTH OF EPINEPHRINE COMPOUNDS IN OPHTHALMOTHERAPY

A NEW EPINEPHRINE OINTMENT

JOSEF D. WEINTRAUB, M.D.
CINCINNATI

Solution of epinephrine hydrochloride U. S. P. is described as having a strength of 1:1,000, or 0.1 per cent, but not of epinephrine hydrochloride, rather of epinephrine base. For a long time the drug in this concentration has been instilled into the eye; it has been used therapeutically to relieve congestion and the attending symptoms in various superficial conjunctival conditions, and diagnostically to blanch the surface vessels and thus render more apparent a suspected deeper perikeratic or ciliary flush or injection. Since 1913 it has been injected subconjunctivally.[1] Since 1925 it has been used on pledgets of cotton placed in the conjunctival sac.[2]

When, in 1931, there was described the use of a stronger solution of epinephrine [3] to dilate the pupil, to distend and break iridolenticular synechiae and to reduce the tension in cases of glaucoma, this same principle of designating strength was used. The convenient, water-soluble bitartrate of synthetic levo-epinephrine was placed on the market in an ampule containing 0.091 Gm. of the salt, equivalent to 0.050 Gm. of epinephrine base, and the percentage strength of the solution was calculated from the epinephrine base content. If the contents of the ampule were dissolved to make 5 cc. of solution, it was designated 1 per cent epinephrine; if the contents were dissolved to make 2.5 cc. of solution, it was designated 2 per cent epinephrine, meaning 1 per cent and 2 per cent, respectively, of the base and not of the salt. These solutions of epinephrine bitartrate did not keep well. In 1935 there was placed on the market a more stable solution of epinephrine hydrochloride containing 1 per cent epinephrine. Although marketed originally for spraying into the nose and pharynx,[4] many oculists, including myself, have been using it to replace the extemporaneously

1. Erdmann: Ueber subkonjunctivale Injektionen von Nebennierenpräparaten und ihre therapeutische Verwendung, Klin. Monatsbl. f. Augenh. **52**:520, 1914.

2. Gradle, H. S.: The Use of Epinephrin in Ocular Hypertension, J. A. M. A. **84**:675 (Feb. 28) 1925.

3. Green, J.: Two Per Cent Epinephrine Solutions as Substitutes for Laevo-glaucosan, Arch. Ophth. **5**:350 (March) 1931.

4. Graeser, James B., and Rowe, Albert H.: The Inhalation of Epinephrin for the Relief of Asthmatic Symptoms, J. Allergy **6**:415 (July) 1935.

prepared 1 per cent solution of epinephrine for instillation into the conjunctival sac.[5]

In the interim, in 1934, there was introduced a preparation consisting of the epinephrine bitartrate salt in a phenolated tragacanth jelly.[6] This product had better preservation qualities than the then available aqueous solution and had the therapeutic advantage of remaining in contact longer than an instilled drop. Inadvertently, and unfortunately, the originator and the drug company which proceeded to market the jelly confused ophthalmologists by changing the percentage designation to one calculated from the total epinephrine bitartrate content rather than from the epinephrine base content. The directions were that the contents of the ampule, 0.091 Gm., be put into 4.5 Gm. of phenolated tragacanth jelly; this was designated as 2 per cent epinephrine jelly, although according to the epinephrine base content it would be 1.11 per cent epinephrine jelly. The directions were further that the contents of the ampule, 0.091 Gm., be put into 9 Gm. of phenolated tragacanth jelly; this was designated as 1 per cent epinephrine jelly, although according to the epinephrine base content it would be 0.56 per cent epinephrine (although 1 per cent epinephrine bitartrate) jelly. Compared with the previous mode of designating percentage strength, the epinephrine content now being supplied in jelly according to these formulas is but little more than half the designated percentage, and differences in results might be associated with the marketing of these weaker preparations.

It is well to continue to designate the strength of preparations of epinephrine base or of epinephrine salts according to the epinephrine base content, as otherwise it is impossible to compare directly the effective strengths of the different preparations. This is equivalent to comparing the substances on the basis of chemical molarity, or preferably chemical normality, and recently I have been using and prescribing epinephrine in terms of normality. The formulas for the ointments are as follows:

Epinephrine bitartrate (1 ampule)	0.091 Gm.
Distilled water	1.1 cc.
An oxycholesterol petrolatum ointment base	1.54 Gm.

Dissolve the contents of the ampule in the distilled water, and incorporate the solution well with the ointment base. Put into a narrow-tipped ophthalmic ointment tube.

This ointment is of tenth-normal strength and contains 1.83 per cent of epinephrine base.

Epinephrine bitartrate (1 ampule)	0.091 Gm.
Distilled water	2.2 cc.
An oxycholesterol petrolatum ointment base	3.17 Gm.

Follow the same directions as for the stronger ointment.

5. Barkan, Otto, and Maisler, S.: Adrenalin Chloride in 1:100 Strength in Ophthalmology, California & West. Med. **46**:150, 1937.

6. Alvis, Bennett Y.: Suprarenin Jelly, Tr. Am. Acad. Ophth. **39**:403, 1934.

This ointment is of twentieth-normal strength and contains 0.92 per cent of epinephrine base.

The chemical normality of a solution, jelly or ointment containing epinephrine depends on the molecular weight of the epinephrine compound used; and it is independent of whether the alkaloid or a salt is used and of which salt is used. A tenth-normal preparation of any epinephrine compound always contains the same amount of epinephrine in a comparable quantity of the pharmaceutic preparation, and designating strength in terms of normality is equivalent to designating strength in terms of epinephrine base content. The particular compound used in a preparation depends on solubility, stability and availability. Should a different, and perhaps more suitable, epinephrine salt be made available in the future, it would be possible to continue to use and prescribe such epinephrine preparations in terms of normality; thereby one salt could be compared directly with another salt or with the base. An additional advantage of prescribing epinephrine preparations in terms of normality is the avoidance of the confusion between the two methods of expressing percentage strength—the older in terms of the base and the newer in terms of the salt.

The ointment with the oxycholesterol absorption base is easily made up, much more conveniently than the tragacanth jelly, and keeps for a reasonable length of time. If desired, a preservative and anesthetic, such as chlorobutanol, may be added by using distilled water saturated with chlorobutanol instead of plain distilled water. The base forms with the solution incorporated with it a creamy white ointment, which melts and spreads readily in the conjunctival sac. This base has the advantage over a simple petrolatum menstruum as it is miscible with the tears. It mixes better than the phenolated tragacanth jelly, which does not spread readily and usually is extruded easily and finds a resting place on the lashes. The proportions of water in the formula may be changed, more water being used to make a softer, more readily spreading ointment, or less water to make a stiffer ointment. The ointment is pharmaceutically desirable and easily made extemporaneously. It is therapeutically more appropriate than a tragacanth jelly for the tear-wetted conjunctival and corneal surfaces.

Clinical Notes

NECROSIS OF THE FRONTAL BONE AND OF THE LACRIMAL GLAND

JOSEPH LAVAL, M.D., NEW YORK

A case of necrosis of the frontal bone and of the lacrimal gland is reported.

J. K., a woman aged 28, presented herself at Dr. Fletcher's clinic at the Manhattan Eye, Ear and Throat Hospital on Nov. 17, 1936, complaining of double vision, which was present occasionally when she looked up. This symptom had been somewhat variable for the past six months, during which time there had also been a vague discomfort about the right eye. There was no history of any other ocular disorder.

Examination showed the vision in each eye to be 20/20 without glasses. A firm rounded mass could be felt under the right orbital ridge at its central portion. It was hard but not bony and was about the size of a small pea; moderate tenderness was elicited on pressure. The right upper lid was slightly lower than the left but could be well elevated. Ocular motility was normal in all fields, there being no limitation of upward gaze. With the red glass, however, diplopia could be brought out when the patient looked upward and to the right. Both fundi were normal.

A roentgenogram of the right orbit taken on the day of admission showed the frontal sinuses to be clear and of average size (fig. 1). There was no evidence of involvement of the ethmoid sinuses other than some thickening of the membrane, nor was there any evidence of involvement of the right supra-orbital ridge except for some slight osseous thickening. The Wassermann and Kahn tests of the blood were both negative. Examination of the blood to rule out the remote possibility of leukemia showed 12,000 white blood cells, with 74 per cent polymorphonuclear leukocytes and 26 per cent small and large lymphocytes. The patient was then examined in the department of otolaryngology, where it was suggested that a mucocele might be present, even though the roentgenogram showed no involvement of the sinuses.

On Jan. 7, 1937, with the patient under ether anesthesia, an incision was made in the skin directly below the right eyebrow down to the superior orbital ridge. Palpation revealed a rounded mass lying along the roof of the orbit under the periosteum. The periosteum was elevated, and the mass, which was about the size of a pea, was freed from the surrounding periosteum. The small mass, together with its enveloping coat of tissue, was then excised. There was found to be no connection with the bony tissue or with the frontal sinus. A small depression was felt in the bony roof of the orbit where the tumor lay. The deep tissues were then approximated with catgut, the wound in the skin was closed with silk sutures and a pressure bandage was applied. Recovery was uneventful.

Examination of the tissue showed some fibrous tissue, which was hyalinized in some areas and more cellular in others. There was also a slight mononuclear inflammatory reaction. A diagnosis was made of fibromatous tissue, probably cicatrix (fig. 2).

The patient was discharged from the hospital on January 11, four days after the operation. About four weeks later she noticed swelling and tenderness temporal to the region of the operation, and a roentgenogram taken at this time, February 4, showed an area of absorption in the supra-orbital ridge at about 10 o'clock. The area did not connect with the frontal sinus, which was clear (fig. 1). No tumor mass could be seen. According to the roentgenographic report, this area was not seen at the first examination on November 17, about two and a half months previously, although a comparison of the first roentgenogram with that taken on February 4 showed the presence of this area of absorption in the former. The swelling gradually increased, and on February 27, a little over seven weeks after the first operation, an incision was made slightly lateral to the region of the

Fig. 1.—Roentgenogram showing clear sinuses. The arrows point to the area of absorption in the supra-orbital ridge at about 10 o'clock.

original operative incision, and much purulent material was disclosed. A drain was inserted, and on March 2, there being no further discharge, the drain was removed, the wound being allowed to close.

Two weeks after the patient's discharge from the hospital, swelling, redness and tenderness appeared again, but this time still more laterally in the frontotemporal region, just beyond the outer limit of the eyebrow. Another roentgenogram taken at this time showed no change in the appearance of the area of absorption in the supra-orbital ridge at about 10 o'clock. On March 16 an incision was made above the right supra-orbital ridge at its extreme temporal area, and a fairly large amount of necrotic and purulent tissue escaped. The incision was carried down to the bone, and more and more of the necrotic material escaped. With

the finger a deficiency in the frontal bone was palpated, through which a probe was inserted into the region of the lacrimal gland. The end of the probe could be palpated lying in the upper fornix and could be seen beneath the conjunctiva. The area of deficiency in the frontal bone was well curetted and was found to be a round hole large enough to admit the tip of the small finger. The deficiency extended down almost to the superior orbital ridge, which was intact and uninvolved. The necrotic tissue of the lacrimal gland was removed, and a rubber drain was inserted through the hole. Two silk sutures were placed in the skin. On March 26 the area was entirely healed, and the patient was discharged. A roentgenogram of the same area taken on March 30 showed no change since the two previous examinations, on February 4 and March 16.

Fig. 2.—Photomicrograph showing areas of fibrous tissue, some hyalinized and some quite cellular.

Examination of the tissue showed necrotic, poorly staining masses of broken-down cells, the original nature of which could not be determined. Some large hydropic cells were seen, which may have been edematous tissue of the lacrimal gland. Mononuclear infiltration was fairly pronounced, and some purulent areas were also seen. The picture resembled that seen in granuloma (fig. 3).

Several days after the last operation the patient stated that three years previously she fell, striking the right side of her head. Some gravel became

impacted in the region of the right brow at this time. Two years prior to the present trouble and again a year before, the same accident befell her. The patient also admitted that on each of these occasions she had been moderately intoxicated.

This case is interesting for two reasons: First, it shows how easily my associates and I were mislead by paying attention to the most prominent symptom, diplopia on upward gaze, and to the most prominent sign, palpation of a firm hard nodule in the orbit. Second, it demonstrates how important it is to get a complete history. I am sure that

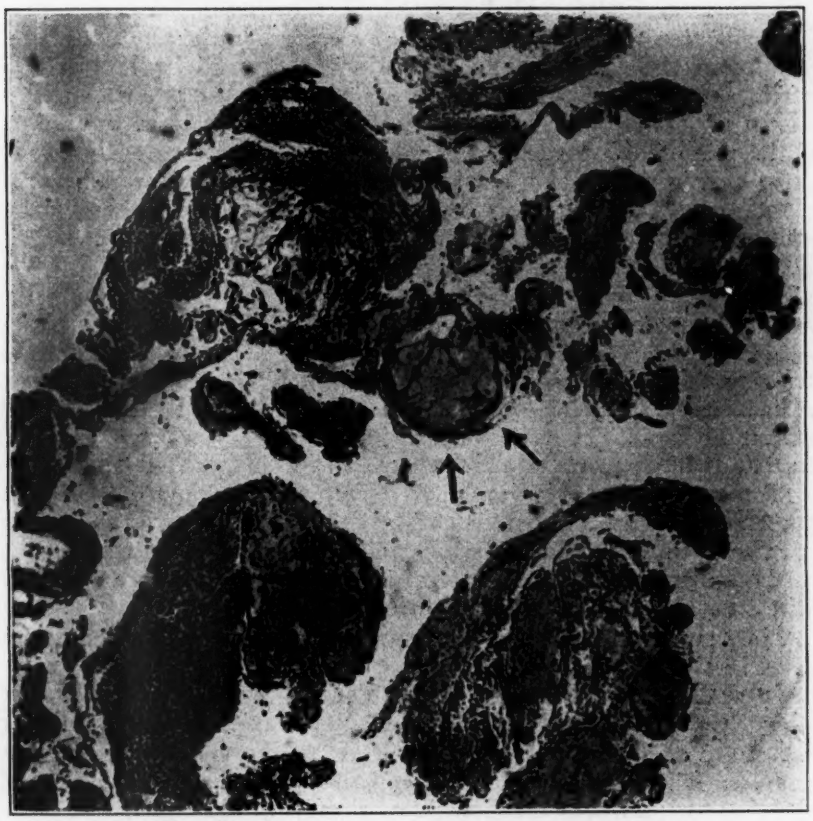

Fig. 3.—Photomicrograph showing necrotic, poorly staining tissue. The arrows point to large hydropic cells, which may have been edematous tissue of the lacrimal gland.

if the history of repeated trauma with the impaction of foreign particles in the region of the right brow had been obtained originally we would have paid more attention to the roentgenogram of this region instead of to that of the orbit as a whole. In that case I believe that the roentgenogram taken in November would have revealed the area of absorption in this region instead of first showing it in February, a month after the first operation.

The fibrous tissue which was removed at the first operation played no part in the production of any of the symptoms or signs. Most likely it was cicatricial tissue resulting from repeated trauma and hemorrhage in this region.

FREE CYST IN THE ANTERIOR CHAMBER

DON MARSHALL, M.D., DANVILLE, PA.

Justification for reporting a case of free cyst in the anterior chamber lies only in the fact that the condition is rare. The literature and theories as to etiology have been well reviewed recently by Clapp [1] and by Evans.[2] Their publications include good illustrations of the gross and the microscopic structure. Evans found thirty-two reported cases of free cyst in the eyeball, but in only nineteen of these was the cyst in the anterior chamber; to this number he added a case of his own. At least two other cases [3] have been described in foreign periodicals since 1928.

The type of cyst here considered is usually less than 2 mm. in its greatest diameter, globular or ovoid and semitransparent, with pigment granules scattered in or over its surface. The outer wall, or capsule, is extremely thin. The contents are clear and fluid. In a few cases the cyst has been kidney shaped or has contained a fold as though made by a constricting band. The specific gravity of such cysts must be greater than that of the aqueous or the vitreous, for in the reported cases the cyst has always settled to the bottom of either the anterior or the vitreous chamber by gravity. Usually the eye otherwise is normal, and the cyst gives rise to no symptoms other than obstruction to vision when it floats across the visual axis and the defect in the cosmetic appearance when it lies in a visible position in the anterior chamber.

A few cysts have been removed surgically from the anterior chamber and, as in Evans' case, on microscopic examination have been found to have a wall of pigment epithelium, derived probably from the iris. Nothing has been observed inside these cysts on microscopic examination.

A study of the recent literature leads to the conclusion that there can no longer be much doubt that a cyst of this type arises from the pigment layer of the iris or the ciliary body. The origin has been discussed for many years. Villard and Dejean [4] in 1933 stated that the mode of

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From the Department of Ophthalmology, the George F. Geisinger Memorial Hospital.

1. Clapp, C. A.: Free Cyst in Anterior Chamber, Am. J. Ophth. **11**:862 (Nov.) 1928.

2. Evans, W. H.: Free Cyst Floating in the Anterior Chamber: Report of Case, Arch. Ophth. **15**:822 (May) 1936.

3. Blidstein-Nevoroshkina, N. I.: Free Cyst in the Anterior Chamber, Russk. j. oftal. **14**:361 (Oct.-Nov.) 1931. Hambresin, L.: Kyste mobile de la chambre antérieure, Bull. et mém. Soc. franç. d'opht. **45**:145, 1932.

4. Villard, H., and Dejean, C.: Les kystes de l'iris, Arch. d'opht. **50**:91 (Feb.); 194 (March); 272 (April) 1933.

development of a wandering cyst is not well understood, but its origin from the iris does not seem to be doubted. A cyst of this type attached along the pupillary margin of the iris has been described in detail and in varying stages of development by Wilmer,[5] Town[6] and Cowan.[7] In recent years reports of cysts of identical characteristics but free in the vitreous chamber have been reviewed by Scarlett,[8] Hurwitz,[9] Seech[10] and Meding,[11] while reports of similar bodies free in the anterior chamber have been reviewed by Clapp and Evans.

REPORT OF A CASE

E. E., a boy of 11 years, was first examined on April 14, 1937, having been referred by an optometrist because of a black object in the anterior chamber of the left eye. This had first been discovered only four days previously by the boy's mother. She had found that it was not fixed in position. No other ocular symptoms were present. There was no history of ocular disease or injury. The mother felt positive that the cyst had not been visible in the eye two weeks before. The patient had not noted any visual disturbance.

Free cyst in the anterior chamber, depicted as a dark object in the angle temporally. The four white spots are highlights on the cornea.

Examination showed an uncorrected visual acuity of 20/15 in each eye. The irides were dark blue or gray, with normal distribution of pigment and no gross

5. Wilmer, W. H.: Cyst of Uveal Layer of Iris at Pupillary Margin, Arch. Ophth. **1**:162 (Feb.) 1929.

6. Town, A. E.: Cyst of the Uveal Layer of the Iris, Am. J. Ophth. **16**:790 (Sept.) 1933.

7. Cowan, A.: Congenital and Familial Cysts and Flocculi of the Iris, Am. J. Ophth. **19**:287 (April) 1936.

8. Scarlett, H.: Floating Cyst of the Vitreous, Arch. Ophth. **2**:619 (Nov.) 1929.

9. Hurwitz, C. E.: Cyst in the Vitreous: Report of Case, Arch. Ophth. **9**:825 (May) 1933.

10. Seech, S. G.: Congenital Cyst in Vitreous, Arch. Ophth. **11**:947 (June) 1934.

11. Meding, C. B.: Free Cyst Floating in the Vitreous, Arch. Ophth. **11**:973 (June) 1934.

clumping. There was a narrow dark brown line of pigment in each eye along the pupillary margin of the iris, of normal size and appearance, as seen under magnification. There were no cysts or other abnormalities or variations in this layer of pigment either when the pupils were dilated or when they were small.

The right eye showed no pathologic process. The left eye was normal and similar to the right, except for a dark brown sausage-shaped body, 2 mm. long and 0.67 mm. in diameter, free in the anterior chamber. One end was rounded; the other end was slightly conical, and near it there was a bend or partial fold in the side of the cyst. The cyst was translucent, with fine particles of pigment scattered somewhat irregularly over its surface. Examination with the slit lamp showed no evidence of strands or connections to other ocular structures, nor were there any vessels or other visible structures inside the cyst. The surface was regular and without projections. The cyst did not move by itself, but when the position of the eyeball and head was varied it would move slowly by gravity to any position in the anterior chamber. With the patient lying on his back, the cyst rested on the iris.

The lens, vitreous and fundus were normal. No other ocular pathologic process was found in either eye. The patient was instructed that surgical removal of the cyst could easily be performed but that such a procedure was not urgent in the absence of symptoms or other ocular disease. No surgical treatment was attempted.

Ophthalmologic Review

FEVER THERAPY FOR OCULAR DISEASES

JOHN S. McGAVIC, M.D.
CINCINNATI

The empiric therapeutic use of artificially induced fever had its origin in antiquity. Only in the last two decades has there been notable progress in the rational or scientific use of fever in combating disease.

The present activity in the field of fever therapy began in 1918, when Wagner-Jauregg published his excellent work on the treatment of dementia paralytica with induced malaria. Nonspecific protein therapy had been introduced only a short time prior to this. In the past six years the production of hyperpyrexia by physical means has been widely studied.

Innumerable diseases of widely divergent character have been treated with fever therapy with equally varying results. Some interest has already been exhibited in this form of therapy by ophthalmologists, particularly in the treatment of syphilitic ocular diseases and gonorrheal ophthalmia and, to a lesser extent, in the treatment of corneal ulcers and iritis of nonspecific origin. After consideration of the rationale of fever therapy, it did not seem unlikely that other diseases of the eye might respond to this treatment.

During the past three years 50 patients with fourteen ocular diseases have received fever therapy at the Cincinnati General Hospital. The first patients were those who had failed to respond to the classic methods of treatment and were in the so-called "hopeless" class. Later, treatment was started earlier in the course of disease, and different types of lesions were treated more or less experimentally.

PURPOSE

This paper is based on the aforementioned series of 50 cases of fourteen ocular diseases in which treatment with one mechanical device, the Kettering hypertherm, was administered. It is my purpose to

From the Department of Ophthalmology and the Department of Fever Therapy of the University of Cincinnati College of Medicine and the Cincinnati General Hospital. This paper is a part of a dissertation submitted to the Graduate School of the university in partial fulfilment of the requirements for the degree of Master of Science. Forty-two of the cases were reported at the First International Conference on Fever Therapy, New York, March 30, 1937. The historical review and summary of physiologic and pathologic changes occurring during and after fever therapy have been omitted as they are not of direct ophthalmologic interest.

report the manner of treatment, the results obtained, and the complications encountered, together with the method of avoidance and the management of these complications. When other treatment was administered, this is noted. An attempt has been made to compare in general the results obtained in cases in which fever therapy was used with those obtained in similar cases in which fever therapy was not employed.

The diagnoses in these 50 cases were as follows:

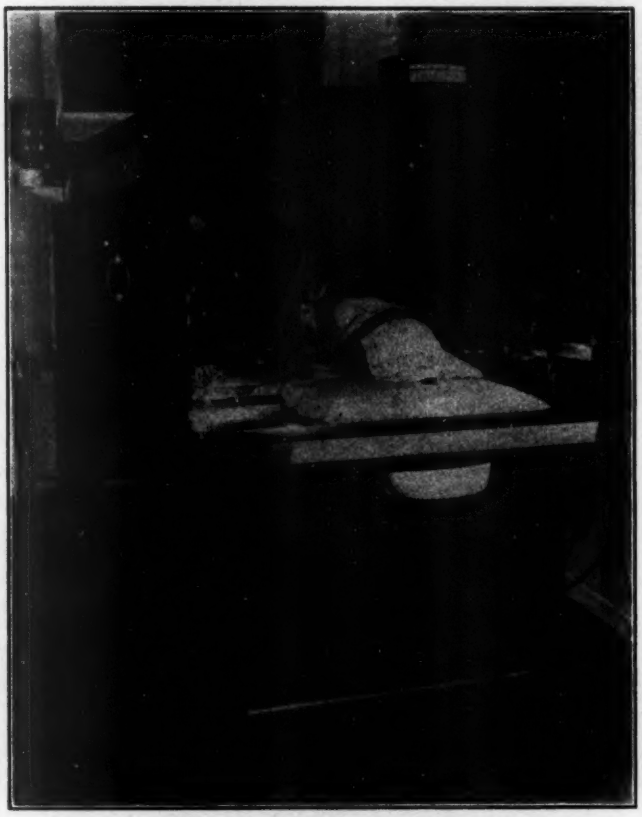
	No. of Cases
Gonorrheal conjunctivitis	11
Gonorrheal iridocyclitis	1
Syphilitic interstitial keratitis	10
Syphilitic iridocyclitis	11
Syphilitic atrophy of the optic nerve	1
Meningovascular syphilis, with paralysis of the intrinsic and extrinsic ocular muscles	1
Meningococcic abscess of the vitreous	2
Phlyctenular keratoconjunctivitis	4
Tuberculous parenchymatous keratitis	1
Tuberculous keratitis and iridocyclitis	1
Corneal ulcer	2
Severe conjunctivitis due to gram-positive diplococci	1
Allergic conjunctivitis	1
Nonspecific uveitis	2
Conjunctivitis, with marginal corneal ulcers	1

This series is obviously too small to be of great value, and one must realize that no definite conclusions should be drawn after observing so few cases. However, a few observations may be of interest to others. In 4 cases the eyes were hopelessly lost when fever therapy was started as a last resort. In 4 cases only a single treatment was administered, so that the results are of no statistical value. These cases are included in order to report every case of ocular disease in which treatment with the Kettering hypertherm was administered.

DESCRIPTION OF KETTERING HYPERTHERM

In its present state the Kettering hypertherm consists of an insulated cabinet in which the nude patient lies, with his head extending outside the cabinet. Insulation with sponge rubber is utilized in the region where the neck projects to permit the patient to shift his position. The patient lies on an air mattress, supported by a boxlike bed, which is rolled in and out at will. In the rear of the cabinet is a small insulated fireproof compartment in which the air-conditioning apparatus is housed. The temperature of the air, as recorded with a dry bulb thermometer, is controlled by a thermostat. The percentage of relative humidity is controlled by a humidistat. The velocity of air within the cabinet is controlled by blowers of fixed speed. The average set of air conditions

to which the patient's body is subjected during the induction of fever is as follows: temperature (dry bulb) of from 130 to 150 F. (from 54 to 65 C.), relative humidity of from 35 to 50 per cent, and velocity of air of 425 cubic feet per minute. The elevation of the rectal temperature to 105 F. (41 C.) is ordinarily accomplished in from forty minutes to one hour. During the maintenance of fever the temperature and velocity of air are reduced. The air is constantly conditioned by continuous passage through the air-conditioning compartment. The



The Kettering hypertherm.

safety and comfort of the patient are greatly enhanced by the accurate control of the relative humidity.

The mechanism of the induction of fever with the Kettering hypertherm depends primarily on the transfer of heat by conduction from the circulating heated air. This factor, combined with prevention of the normal rate of loss of heat from the body by radiation and evaporation, is responsible for the elevation of the body temperature and its maintenance at any desired level.

The simplification of the apparatus and the removal of hazards inherent in certain other physical modalities have converted this form

of therapy from one requiring hospitalization of the patient to one which usually permits him to return to work the day after treatment.

Fifty-five of these units have been lent to twenty medical research centers, strictly for investigative purposes. The physicians and nurses charged with this undertaking received special training in the department of fever therapy research at the Miami Valley Hospital before the apparatus was released. A simpler, smaller and less costly apparatus is now being developed. It is probable that it will ultimately be available on a loan-lease basis to certain qualified institutions.

TECHNIC OF TREATMENT

The successful administration of treatment with the hypertherm depends on the following factors: (1) the selection of patients from the standpoint of physical condition and mental stability, (2) the proper psychologic conditioning, (3) the medical preparation of the patient and medical care while the treatment is in progress and (4) the nursing care.

Each patient is examined to rule out any of the following conditions considered as contraindications: age above 60, cardiovascular disease (excepting acute rheumatic carditis), renal disease, active pulmonary tuberculosis, hypertension regardless of cause, and diabetes unless carefully controlled. Desjardins and his co-workers [1] do not consider well controlled diabetes as a contraindication.

Simpson [1a] reported the successful treatment of 3 pregnant women who gave birth to full term, normal babies. One patient had acute gonorrheal arthritis, and 2 had advanced dementia paralytica which had resisted all other forms of treatment. The two babies were nonsyphilitic.

Before a patient is sent to the department of fever therapy for his first treatment, he is told as much about it as seems advisable. An attempt is made to anticipate, and then to dissipate, his fears and to send him away as composed and cooperative as possible. For some reason, cooperative patients seem to obtain better results.

The patient receives the following preparatory routine: (1) 250 cc. of orange juice and 250 cc. of 5 per cent dextrose the night before treatment; (2) a mild sedative at bedtime; (3) 20 grains (1.29 Gm.) of calcium lactate at bedtime; (4) orange juice, dextrose and calcium lactate in the morning, in the same quantities as given the night before;

1. Desjardins, A. U.; Stuhler, L. G., and Popp, W. C.: Fever Therapy for Gonococcic Infections, J. A. M. A. **104**:873 (March 16) 1935.

1a. Simpson, W. M., in discussion on Hartman, F. W., and Major, R. C.: Abstracts of Papers and Discussions, Fifth Annual Fever Conference, Dayton, Ohio, May 1935.

(5) a light breakfast, or none, and a cleansing enema, and (6) 10 cc. of calcium gluconate intramuscularly just before treatment.

During the period of fever treatment intelligent nursing care is of the utmost importance. One nurse is constantly with the patient. Every means of providing as much physical comfort as possible is employed. Constant reassurance relieves the understandable anxiety experienced by the patient. Were it not for the excellence of the nurses, who are vitally interested in their work, much more opposition and many more complications would be encountered.

The nursing care of the patient in the box is as follows:

1. The head is outside of the box. This does not affect the temperature of the eye, even though the head is sponged frequently with ice. The patient is covered with blankets in the box.

2. The period of induction is from one to one and one half hours' duration, during which time sedation is given when necessary. Sedation is kept at an absolute minimum; ⅙ grain (0.01 Gm.) of pantopon (a mixture of the hydrochlorides of the opium alkaloids) or ½ grain (0.03 Gm.) of codeine sulfate (administered hypodermically) may be used. Barbiturates are not recommended as the patients have peculiar mental reactions. The use of morphine is avoided as it often causes nausea and vomiting.

3. Fluids are withheld until fever is attained.

4. A temperature of from 105 to 107 F. is maintained for five hours.

5. As much cool 0.6 per cent saline solution is given by mouth as the patient will take. This is well tolerated and helps maintain the chloride balance.

6. No local treatment is given to the eyes during fever therapy, except in cases of gonorrheal conjunctivitis, when they are kept free from pus.

7. The blankets are changed frequently and the patient is rubbed with ice.

8. The temperature is taken rectally every five minutes.

9. The pulse is counted every ten or fifteen minutes.

10. The blood pressure is taken if other signs indicate the necessity.

The after-care of the patient consists of the following measures:

1. Covers are removed near the end of the treatment.

2. The patient is removed from the box.

3. A bath with soap and water is given.

4. The patient is watched closely for one hour. The blood pressure, pulse rate and temperature are taken three or four times. The temperature usually falls in one-half hour to 100 F.

5. The patient is returned to the ward and remains in bed until he wants to get up. If he is an outpatient, he may go home two hours after completion of the treatment.

GONORRHEAL INFECTION OF THE EYE

The rationale of the fever treatment of gonococcic infections is definitely established. Neisser and Scholtz [1b] had difficulty in cultivating the gonococcus in patients with fever. Remissions and even cures had been noted in patients having intercurrent febrile diseases. Laboratory workers found that the organism grew poorly on artificial mediums at temperatures above 100 to 104 F. The gonococcus resists high temperature better in vivo than in vitro (Koch and Cohn [2]).

Wagner-Jauregg credited Bering [3] with having introduced malaria for the treatment of gonorrhea in 1924.

Injections of foreign protein and chemicals have also proved successful. Boak, Carpenter and Warren [4] paved the way to the successful clinical application of fever therapy by studying the thermal death gradient of many strains of gonococci. They proposed to find how long it would take to kill each strain at temperatures tolerable to man.

Carpenter, Boak, Mucci and Warren [5] stressed the importance of knowing the thermal death time of the particular strain of gonococcus involved, so that treatment might be given accordingly. They found that in fifteen strains 99.7 per cent of the organisms were killed after from four to five hours at 105.8 F. and 99 per cent were nonviable after two hours at 105.8 F. The remaining 1 per cent were killed in from five to twenty hours at a temperature of from 106 to 107 F. Simpson and his co-workers [6] repeated this experiment, with almost

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1b. Neisser, A., and Scholtz, W.: Gonorrhoe, in Kolle, W., and Wassermann, A.: Handbuch der pathogenen Mikroorganismen, Jena, Gustav Fischer, 1903, vol. 3, p. 168; cited by Kendall, Webb and Simpson.[6]

2. Koch, J., and Cohn, A.: Gonokokkeninfectionen, in Kolle, W.; Kraus, R., and Uhlenhuth, P.: Handbuch der pathogenen Mikroorganismen, ed. 3, Jena, Gustav Fischer, 1928, vol. 4, p. 705; cited by Desjardins, Stuhler and Popp.[1]

3. Bering, quoted by Wagner-Jauregg, J.: Message from Prof. Wagner-Jauregg, Proc. First Internat. Conf. Fever Therapy, December 1937.

4. Boak, R. A.; Carpenter, C. M., and Warren, S. L.: Thermal Death Time of One Hundred and Thirty Strains of Neisseris Gonorrhoeae. Idea: The Basic Principles for the Cure of Gonococcal Infections by a Single Fever Treatment, Abstracts of the Fifth Annual Fever Conference, Dayton, Ohio, May 1935.

5. Carpenter, C. M.; Boak, R. A.; Mucci, L. A., and Warren, S. L.: Studies on the Physiologic Effects of Fever Temperatures, J. Lab. & Clin. Med. **18**:981 (July) 1933.

6. Kendell, W. H.; Webb, W. W., and Simpson, W. M.: Artificial Fever Therapy of Gonorrheal Arthritis, Am. J. Surg. **24**:428 and 452 (Sept.) 1935.

identical results. Krusen, Stuhler and Randall [7] advocated a single ten hour treatment at 106 F., lest the organism become more heat resistant by frequent temperature elevations of lesser duration.

Many scattered reports have been uniformly favorable concerning the results of fever treatment in practically all gonococcic infections. Metz,[8] Hasler and Spekter,[9] Janet and Dreyfus,[10] Belt and Folkenberg [11] and Trautman, Stroupe and Devlin [12] have reported successful treatment of a few patients with gonorrheal ophthalmia by hyperpyrexia.

Report of Seven Cases of Gonorrheal Conjunctivitis.—Response to fever therapy in 11 cases of gonorrheal ophthalmia was most satisfactory. As stated previously, most strains of the gonococcus are killed directly by the temperature attained. Some strains are more heat resistant, and the response in these cases may require some other explanation. Until some method of determining what defense mechanism is stimulated and how this is accomplished by any method, one must be content to assume that "some beneficial reaction" occurs. It is, of course, most probable that all strains can be killed at temperatures safe to use therapeutically, if maintained for sufficiently long periods.

Heat therapy seems to increase the amount of pus formed in the conjunctival sac after the first and second treatments. Thereafter the discharge steadily diminishes, and smears become negative in from about one-third to one-half the time required in cases in which local treatment without heat is used. Additional treatment consists in the following measures: special nursing care, keeping the eyes as nearly free from pus as possible, irrigations with a bland solution (a solution of potassium permanganate in a concentration of 1: 10,000) and dilation of the pupils with atropine.

In no patient with clear, uninvolved corneas on admission to the hospital did corneal ulceration or clouding develop after treatment. In the 5 patients who had corneal involvement on admission, no increase in clouding occurred. It appears that the end results were better in these cases than in similar ones in which treatment did not include fever therapy. This is difficult to determine, as many clouded or ulcerated corneas finally become completely, or almost completely, clear after the usual local treatment; this is especially true in infants and very young children. One cannot draw definite conclusions concerning corneal involvement until more patients and more controls are available.

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7. Krusen, F. A.; Stuhler, L. G., and Randall, L. M.: Fever Therapy Plus Additional Local Heating in the Treatment of Gonorrheal Infections, Proc. First Internat. Conf. Fever Therapy, December 1937.

8. Metz, M. H.: Results Obtained by the Use of Fever Therapy, J. A. M. A. **106**:1658 (May 9) 1936.

9. Hasler, W. T., Jr., and Spekter, L.: Artificial Fever in the Treatment of Gonorrheal Ophthalmia, J. A. M. A. **107**:102 (July 11) 1936.

10. Janet, J., and Dreyfus, M. R.: La pyrétothérapie des affections gonococciques, Ann. d. mal. vén. **32**:421 (June) 1937.

11. Belt, A. E., and Folkenberg, A. W.: Incidence of Cure in Gonococcal Infections Subjected to One Hyperpyrexia Treatment of Ten Hours' Duration at 106.8 F., Proc. First Internat. Conf. Fever Therapy, December 1937.

12. Trautman, J. A.; Stroupe, H. V., and Devlin, D. J.: Fever Therapy in Gonococcal Infections, Proc. First Internat. Conf. Fever Therapy, December 1937.

Two of the 11 patients had spontaneous rupture of the cornea shortly after admission. Both had been neglected when first seen. Fever treatments were continued to clear up the purulent discharge and to lessen the likelihood of infection of the second eye. Healing was rapid in both instances.

Two patients had concurrent arthritis, which responded to heat therapy with rapidity and completeness. No recurrence of arthritis had occurred after ten and three months, respectively. Four patients had gonorrheal urethritis during the time of treatment.

The more rapidly a gonococcic infection of the conjunctiva can be cured and the more nearly free from pus the conjunctival sac can be

TABLE 1.—*Data on Eleven Cases of Gonorrheal Conjunctivitis*

Patient	Age, Years	Extent of Involvement*	Days in Hospital	Number of Days Positive	Number of Treatments	Total Hours of Treatment	Corneal Ulceration	Perforation	Residual scar	Final Vision†
A. A.	20	O. S.	20	2	3	2½	3 mm.; shallow	No	Nebula	20/20 and 20/15
J. D.	6	O. S.	14	2	3	16	4 mm.; shallow	No	Nebula	Reading vision in each eye
R. T.	53	O. D.	54	6	4	5½	8 by 3 mm.; deep ulcer near limbus	No	Crescentic leukoma	20/30 and 20/20
F. R.	9	O. U.	32	4	6	19½	6 by 8 mm.; deep ulceration in left eye	Yes	Entire cornea opaque	20/30 and perception of light
J. L.	22	O. S.	16	3	5	15	Tiny superficial ulcer at limbus	No	None	20/30 and 20/30
G. F.	9	O. S.	9	3	2	11	None	No	None	20/30 and 20/30
B. W.	4	O. U.	8	1	2	6	None	No	None	20/20 and 20/20
M. B.	9	O. S.	10	1	2	9½	None	No	None	20/20 and 20/20
P. H.	22	O. U.	40	10	9	38	5 by 5 mm.; deep central ulcer in left eye	Yes	Entire cornea opaque	20/20 and perception of light
R. J.	4	O. D.	21	18	1	5	None	No	None	20/20 and 20/20
W. C.	13	O. U.	7	2	3	15	None	No	None	20/20 and 20/20

* O. U. indicates each eye; O. D., the right eye, and O. S., the left eye.
† Reading vision is equivalent to about 20/40.

kept by the nurses, the less likelihood there is of corneal damage from the toxins present. Therefore, it seems that heat treatments should be given as frequently as the patient can tolerate them.

It is to be regretted that newborn infants with gonorrheal conjunctivitis cannot be treated by fever, as such patients are in the majority, although the infection is usually less severe than in adults.

Recently 4 patients with gonorrheal conjunctivitis were treated with sulfanilamide, given orally in doses of from 40 to 90 grains (2.59 to 5.82 Gm.) a day. The results were satisfactory. Two of the patients had gonorrheal urethritis, which responded clinically in five and six days, respectively. In 1 a low grade fever developed, and the patient was somewhat cyanotic during the period of administration of the drug.

Both of these complications subsided after the sulfanilamide was discontinued. This drug can be given to infants as well as to adults.

If further study of this method of treatment proves that it is effective, fever therapy will certainly be supplanted by this safer, cheaper and more comfortable management. It is too early to be able to state definitely how efficacious sulfanilamide will be, but the reports so far made justify its use under carefully controlled conditions. About from 10 to 15 per cent of patients cannot tolerate sulfanilamide.

Report of a Case of Gonorrheal Iridocyclitis.—The patient was admitted from the clinic with exudative iridocyclitis attributed to the gonococcus. Other than gonorrheal urethritis, no cause for the iridocyclitis could be found. A few gram-negative diplococci were found in conjunctival epithelial scrapings. No purulent conjunctivitis was present, and none developed. The tension was elevated, and posterior synechiae and hypopyon were present. After fever therapy the patient had a prompt subsidence of the congestion of the iris; the synechiae were broken (atropine was used locally); the hypopyon absorbed rapidly, and the tension was reduced to normal without paracentesis being necessary. Three treatments, comprising a total of thirteen hours of therapy, were sufficient to accomplish complete cure. Final vision was 20/25 in each eye.

OCULAR SYPHILIS (INTERSTITIAL KERATITIS, IRIDOCYCLITIS AND ATROPHY OF THE OPTIC NERVE)

Ocular syphilis has presented no less a problem than other manifestations of the disease. Crisp,[13] an ophthalmologist, once wrote an editorial entitled "The Incurability of Syphilis," basing it on the many recurrences of ocular manifestations in patients receiving adequate chemotherapy for many years and having negative serologic reactions consistently. It is not strange, therefore, that many workers have sought another method of treatment when chemotherapy has failed to cure a disease which causes at least 10 per cent of all blindness.

There are adequate experimental and clinical data to support the premise that syphilitic lesions respond favorably to hyperpyrexia.

Eighteen years ago Weichbrodt and Jahnel[13a] reported that scrotal chancres in rabbits whose temperatures were elevated to 104 and 107 F. in incubators for thirty minutes once or twice daily for from three to five weeks healed more rapidly than chancres in untreated rabbits. After the second day the spirochetes lost their motility, decreased in number and disappeared.

13. Crisp, W. H.: The Incurability of Syphilis, Am. J. Ophth. **16**:821 (Sept.) 1933.

13a. Weichbrodt, R., and Jahnel, N.: Einfluss hoher Körpertemperaturen auf die Spirochaeten und Krankheitserscheinungen der Syphilis in Tierexperiment, Deutsche med. Wchnschr. **45**:483 (May 1) 1919.

In 1926 Schamberg and Rule [14] were able to prevent the development of syphilitic lesions in rabbits whose testes had been inoculated with spirochetes by daily elevation of the temperature of 4 degrees F. They also cured definite chancres of the scrotum by fifteen daily elevations of the temperature of from 5.2 to 5.8 degrees F. No spirochetes were found after eight days; the testes were normal in seventeen days. Furthermore, they could not produce syphilitic lesions in other rabbits by the injection of popliteal and inguinal lymph node tissue from the infected and heat-treated rabbits into the testes of normal rabbits.

The same workers [15] treated 11 syphilitic persons with hot baths and noted regression of eruptive lesions and favorable serologic reactions in practically all.

Bessemans and his co-workers [16] were able to cure or prevent scrotal chancres in rabbits by local or general hyperpyrexia of 104 F. for two hours, or 107.6 F. for one hour (intratesticular temperatures as measured by the thermopile).

Carpenter, Boak and Warren [17] showed that experimental syphilis in rabbits could be effectively treated by hyperpyrexia. They studied the thermal death gradient of Spirochaeta pallida in vitro. Temperatures of 102.2 F. for five hours, 104 F. for three hours, 105.8 F. for two hours and 106.7 F. for one hour were required to render material from infected, treated rabbits noninfectious to other rabbits. Levaditi and

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14. Schamberg, J. F., and Rule, A. M.: Studies in the Therapeutic Effect of Fever in Experimental Rabbit Syphilis, Arch. Dermat. & Syph. **14**:243 (Sept.) 1926.

15. Schamberg, J. F., and Rule, A. M.: The Effect of Extremely Hot Baths in Experimental Syphilis, Arch. Dermat. & Syph. **17**:322 (March) 1928.

16. Bessemans, A.; de Potter, F., and Hacquaert, R.: Sur deux formes d'aéro-thermothérapie locale des syphilones testiculaires primaires du lapins, Compt. rend. Soc. de biol. **100**:757 (March 15) 1929. Bessemans, A.; Vercoullie, J., and Hacquaert, R.: Nouvel essai de thermoprophylaxie sociale antisyphilitique; traitement aére-thermique local du chancre primaire, Rev. belge sc. méd. **1**:425 (May) 1929; Influence de diverses applications locales de la chaleur sur les accidents syphilitiques primaires et secondaires chez l'homme, Compt. rend. Soc. de biol. **101**:483 (June 14) 1929. Bessemans, A.: Local Application of Heat as an Adjunct in the Social and Individual Prophylaxis of Syphilis: Role of Tissue Temperature in Pathogenesis and General Pyretotherapy of Syphilitic Infection, Urol. & Cutan. Rev. **34**:71 (Feb.) 1930. Bessemans, A., and Thiry, U.: New Experiences with the Application of Local Heat Therapy (Hot Water Baths and Diathermy by Long Waves Slightly Damped) in the Treatment of Primary and Secondary Syphilis in Man, ibid. **37**:377 (June) 1933; cited by Simpson.[20]

17. Carpenter, C. M., and Boak, R. A.: Effect of Heat Produced by an Ultra-High Frequency Oscillator on Experimental Syphilis in Rabbits, Am. J. Syph. **14**:346 (July) 1930. Boak, R. A.; Carpenter, C. M., and Warren, S. L.: Healing of Experimental Syphilis in Rabbits by Short Wave Fevers, J. Exper. Med. **56**:751 (Nov.) 1932; Thermal Death Time of Treponema Pallidum in Vitro, with Special Reference to Fever Temperatures, ibid. **56**:741 (Nov.) 1932.

de Rothschild [18] performed similar experiments, with less constant results.

Kolmer and Rule [19] were able to prevent infection and to cure experimental syphilitic lesions by hot water baths. Injections of typhoid vaccine and of a mixture of erysipelas and prodigiosus toxins were much less effective in this experiment than were hot baths.

Simpson [20] and others have done excellently controlled experimental work with equally dramatic results. Kyrle,[21] Kemp and Stokes,[22] Richet and Dublineau,[23] Wagner-Jauregg,[24] O'Leary,[25] Jacobs and Vohwinkel,[26] Bering [27] and others have emphasized that chemotherapy combined with fever therapy of any type is more effective than either one alone in the treatment and prevention of neurosyphilis.

With the exception of reports of cases of syphilitic interstitial keratitis, published reports of cases of ocular syphilis in which artificial fever therapy was used are not numerous. In 1925 Huber [28] reported the successful use of foreign protein in the treatment of this manifesta-

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18. Levaditi, C., and de Rothschild, H.: Etude expérimentale de la thermothérapie générale par les radiations à ondes courtes, Ann. Inst. Pasteur **52**:23 (Jan.) 1934.

19. Kolmer, J. A., and Rule, A. M.: Hot Baths in Experimental Primary Syphilis of Rabbits and in Trypanosomiasis of Rats, Arch. Dermat. & Syph. **27**: 660 (April) 1933.

20. Simpson, W. M.: Artificial Fever Therapy of Syphilis and Gonococcic Infection, New York State J. Med. **36**:1 (Sept.) 1936.

21. Kyrle, J.: Die Malariabehandlung der Syphilis, Wien. klin. Wchnschr. **37**:1105 (Oct. 23) 1924; cited by Simpson.[20]

22. Kemp, J. E., and Stokes, J. H.: Fever Induced by Bacterial Proteins in the Treatment of Syphilis, J. A. M. A. **91**:1737 (May 25) 1929.

23. Richet, C., Jr., and Dublineau, J.: Pyréto et chimiothérapie associées dans le traitement de la syphilis du lapin, J. de physiol. et de path. gén. **31**:794 (Sept.) 1933. Richet, C., Jr.; Dublineau, J., and Joly, F.: Pyréto et chimiothérapie associées dans la syphilis primaire et secondaire; étude expérimentale et clinique, Presse méd. **41**:1649 (Oct. 25) 1933. Richet, C., Jr., and Dublineau, J.: La pyrétothérapie de la syphilis, Paris méd. **1**:197 (March 3) 1934; cited by Simpson.[20]

24. Wagner-Jauregg, J.: Malariatherapie, Wien. med. Wchnschr. **78**:275 (Feb. 25) 1928; Ueber maximale Malariabehandlung der progressiven Paralyse, Klin. Wchnschr. **13**:1028 (July 14) 1934.

25. O'Leary, P. A.: Treatment by Malaria in Asymptomatic Neurosyphilis, J. A. M. A. **97**:1585 (Nov. 28) 1931.

26. Jacobs, J., and Vohwinkel, K. H.: Die Malariatherapie der Früh und Spätlues, Dermat. Ztschr. **57**:321 (Jan.) 1930; cited by Simpson.[20]

27. Bering, F.: Die Malariabehandlung im Frühstadium der Syphilis des Zentralnervensystems, Zentralbl. f. Haut- u. Geschlechtskr. **17**:41 (June 5) 1925.

28. Huber, R.: Keratitis parenchymatosa, Klin. Monatsbl. f. Augenh. **75**:252, 1925.

tion of congenital syphilis. Malarial therapy for interstitial keratitis was instituted by Schreiber [29] in 1928.

Culler and Simpson [30] first reported the use of the Kettering hypertherm in 58 cases of ocular syphilis, representing 7 different manifestations of the disease.

Simpson and Kendell [31] reported the clinical application of the quantitative Kahn reaction as a reliable and sensitive index to the progress of a syphilitic patient during the course of treatment. This contribution is of great value in all cases and of especial value in certain cases in which the qualitative or diagnostic Kahn reaction remains positive, despite treatment and in the face of definite clinical improvement.

Syphilitic Interstitial Keratitis.—Since Hutchinson first correlated interstitial keratitis and congenital syphilis, there has been a more or less fatalistic attitude toward the results of treatment. Spicer [32] stated that results for 45 untreated patients did not compare unfavorably with those for the 614 treated patients in his series. Fisher,[33] as late as 1927, was doubtful that chemotherapy altered the course of the disease. Carvill and Derby [34] in 1925 published a report of the results in the most complete and best controlled series of cases ever cited in the literature. From 756 patients, they selected 100 untreated, or poorly treated, patients and 100 intensively treated patients for comparison. They concluded that chemotherapy had some influence on the prevention of an attack in the second eye and that perhaps antisyphilitic therapy made this attack less severe in some cases. The vision of the treated patients was found to be better than that of the untreated, or poorly treated, patients, and recurrences were much less frequent in the former. They were distinctly dissatisfied with the results of the treatment, even when injections of milk and diphtheria antitoxin were used with chemotherapy.

One reason for this fatalistic attitude is that interstitial keratitis is a self-limited disease. Corneal scars are variable and may become

29. Schreiber, L.: Treatment of Keratitis Parenchymatosa with Malaria, Ztschr. f. Augenh. **66**:316, 1928; cited by Culler and Simpson.[30]

30. Culler, A. M., and Simpson, W. M.: Artificial Fever Therapy in Cases of Ocular Syphilis, Arch. Ophth. **15**:624 (April) 1936.

31. Simpson, W. M., and Kendell, H. W.: Experimental Treatment of Early Syphilis with Artificial Fever Combined with Chemotherapy, Am. J. Syph., Gonor. & Ven. Dis. **21**:526 (Sept.) 1937.

32. Spicer, W. T. H.: Parenchymatous Keratitis; Interstitial Keratitis; Uveitis Anterior, London, George Pulman & Sons, 1924; cited by Culler and Simpson.[30]

33. Fisher, J. H.: Discussion of the Value of Recent Methods of Treatment in the Late Stages of Ocular Syphilis, Proc. Roy. Soc. Med. **20**:954, 1927.

34. Carvill, M., and Derby, C. W.: Interstitial Keratitis, Boston M. & S. J. **193**:403 (Aug. 27) 1925.

almost completely absorbed after long periods with or without treatment. A more detailed description of the type of lesion and more accurate reports on the final visual acuity would add greatly to the value of case reports. The difference in prognosis in the vascularized or recurrent types as opposed to that in the type in which there is a central opaque disk of plastic exudate was brought out by Spicer and reemphasized by Culler and Simpson,[30] who found that the otherwise most unfavorable type in which a central plastic exudate was present responded best of all to treatment with the hypertherm. They expressed the belief that the reason for favorable reports published by those using injections of malarial organisms and typhoid vaccine was that a similar resolution of this exudate is effected by these agents, whereas chemotherapy does not seem to have much effect on this type of keratitis.

The object of using artificial fever for this disease is to obtain a shortened course, with relief from symptoms, in the hope that the resulting scars will be less dense because of the earlier and more rapid resolution. A discrepancy was noted between the marked immediate relief of pain, blepharospasm, lacrimation and photophobia and the actual clearing of the corneal stroma. This is especially true in cases in which there is corneal vascularization and in which the inflammation has been present for a long time before fever therapy has been started.

Report of Ten Cases of Syphilitic Interstitial Keratitis.—The results in 10 cases of syphilitic interstitial keratitis were more impressive than those in cases of any other type of ocular disease treated. It seemed almost unbelievable that patients who usually stayed in the hospital for from six to eight weeks before being appreciably improved would open the eyes and leave them open after one or two treatments. Response to chemotherapy, atropinization, hot compresses and the best of supportive treatment had been most disappointing in previous cases.

One patient had Clutton's joints; chemotherapy had been tried, with no response, but the condition responded functionally to fever therapy.

Six of the 10 patients had had previous courses of antisyphilitic therapy before admission to the department of fever therapy. Four had no previous treatment. The following results were noted:

1. The more acute the condition, the better was the response, both subjectively and objectively.

2. Subjective relief of photophobia, blepharospasm, pain and excessive lacrimation occurred after the first treatment, and progressive improvement was noted with each successive treatment. This allowed better examination of the eyes and more efficient local treatment.

3. Better dilation of the pupil was obtained with the combined use of atropine and heat than with atropine alone.

4. The period of activity was shortened; hence, the period of hospitalization.

5. Resultant corneal scarring was slight.

6. All the patients had useful vision after the attack.

Heat therapy is apparently most advantageous in the acute stage of syphilitic interstitial keratitis and when considerable exudation into the

corneal stroma is present. Since this is the type which results in the most persistent scar formation, heat therapy used promptly in such cases would seem to be the ideal method of treatment. Certainly anything which shortens the duration of the condition will decrease the amount of residual scarring.

It should be said that there is great variation in the resulting scar in different persons with keratitis, whether untreated or whether treated with chemotherapy alone, with chemotherapy and local treatment combined, with local treatment only, or with any of the foregoing methods combined with the injection of malarial organisms, typhoid vaccine or similar agents. It is therefore difficult to decide how much patients are actually helped and in which ones only slight scarring or vascularization would result if treatment were not given. However, the astounding subjective relief and shortened duration of the attack alone would be sufficient reason for advocating fever therapy.

Syphilitic Iridocyclitis.—Culler and Simpson [30] reported 10 cases of syphilitic uveitis with results almost identical with those found in the cases subsequently reported. Benedict and Whitney [35] in discussing this report stated that their own results had been excellent. Hambresin and Mawas [36] described favorable results with the use of sulfur in oil, malaria and short wave therapy.

Objections may be raised to the advisability of subjecting such patients to so strenuous a treatment when chemotherapy and atropine alone are sufficient in many cases. There are two excellent reasons; first, iritis is most frequently a manifestation of secondary syphilis, and results of fever therapy in this stage are excellent, not only for ocular but for systemic syphilis; second, one cannot anticipate which patients will be so refractile to chemotherapy as to necessitate fever therapy until much damage has been done to the eye.

It seems, therefore, not only permissible but advisable to use fever therapy when a patient first is observed to have syphilitic iritis. The infection is treated at the time the response to fever is best, and the patient may be saved from future ocular lesions or lesion of the vascular or nervous systems. Chemotherapy is given an opportunity to exert its greatest influence on the spirochete during hyperpyrexia.

Report of Eleven Cases of Syphilitic Iridocyclitis.—A year ago 4 cases of syphilitic iridocyclitis of comparable severity, in all of which there were secondary cutaneous manifestations, were studied. Two patients were treated with fever therapy plus the use of atropine locally, while chemotherapy was withheld with the consent of the patients. The other 2 were given chemotherapy plus the use of atropine and hot compresses locally. The objective and subjective

35. Benedict, W. L., and Whitney, E. L., in discussion on Culler and Simpson.[30]

36. Hambresin, L., and Mawas, J.: Fever Therapy in Ophthalmology, Proc. First. Internat. Conf. Fever Therapy, December 1937.

TABLE 2.—*Data on Ten Cases of Syphilitic Interstitial Keratitis*

Patient	Age, Years	Extent of Involvement*	Previous Antisyphilitic Treatment	Duration of Treatment Prior to Fever Therapy	Corneal Involvement	Number of Treatments	Total Hours of Treatment	Vision on Admission	Final Vision†
L. L.	10	O. U.	None	21 days	Plastic exudates; iridocyclitis	6	26	Hand movements at 4 feet in each eye	Reading vision in each eye uncorrected
G. C.	12	O. U.	.....	.....	Diffuse vascularization; small amount of exudate	12	47	20/160 and 20/80	20/50 and 20/50 uncorrected
M. W.	10	O. D.	.....	.....	Small areas of vascularization; slight exudation	3	11¼	.....	20/40 and 20/30 uncorrected
E. A.	5	O. S.	None	7 days	Central opaque exudates	9	27	20/30 and perception of light	20/30 and reading vision uncorrected
L. T.	9	O. U.	For 5 mo.	6 mo.	Central opaque exudates; moderate vascularization	11	37	Hand movements at 2 feet in each eye	20/50 and 20/65
L. J.	8	O. U.	For 2 mo.	2 mo.	Exudation and vascularization centrally	6	12	20/200 in each eye	20/20— in each eye
E. W.	9	O. U.	None	3 wk.	Vascularization; slight exudate	13	47	20/200 and hand movements at 2 feet	20/20 and 20/40
M. L.	..	O. U.	None	3 mo. in each eye 2 wk. in right eye	Vascularization and exudation	8	32	.....	20/20 and 20/20
Ea. W.	12	O. S.	3 yrs. ago	3 wk.	Marked vascularization; moderate exudation	6	28	20/200 and 20/40	20/25 and 20/25
J. R.	9	O. D.	None	.....	Marked exudation of entire cornea	4	20	Hand movements at 2 feet in right eye; 20/30 in left eye	Reading vision and 20/30

* O. U. indicates each eye; O. D., the right eye, and O. S., the left eye.
† Reading vision is equivalent to about 20/40.

ocular phenomena were recorded, along with the results of repeated dark field examinations of the cutaneous lesions, all of which were positive when the patients were admitted to the hospital.

All 4 patients had rigid posterior synechiae, muddy congested irides, marked injection of the ciliary body and marked signs of irritation of the iris, with photophobia, pain and excessive lacrimation. Iritis was well established.

The patients who were treated with heat obtained more rapid and complete subjective relief, better dilatation of the pupil, fewer and smaller synechiae and more prompt diminution of the circumcorneal injection. The cutaneous lesions remained positive on dark field examination at least eighteen days after admission of the patients to the hospital, and the lesions faded slowly. The administration of neoarsphenamine was started twenty-five days after admission, and the cutaneous lesions disappeared rapidly thereafter.

The patients treated with neoarsphenamine immediately on admission showed rapid fading of the cutaneous lesions, no spirochetes being found on dark field examination about ten days after admission. However, the iridocyclitis responded much more slowly, and the residual synechiae were broader and more firm. Subconjunctival injections of solutions of atropine and epinephrine hydrochloride failed to break up the synechiae.

The remaining 9 patients in this group of 11 were seen in the clinic earlier in the course of the iridocyclitis. All were given chemotherapy and fever therapy concurrently, and atropine and hot compresses were used locally. In only 2 cases was the condition as severe as that in the 4 cases mentioned previously. Response to fever therapy was rapid, both subjectively and objectively. While the condition in these cases was less severe and treatment was given earlier, the combined fever therapy and chemotherapy seemed to afford more rapid clearing of the objective signs than did heat alone or chemotherapy alone. One of the patients received fever therapy alone for two treatments, which were given one day apart. The iris appeared worse than on admission. A course of treatment with neoarsphenamine was started, and improvement was prompt. The patient had received a previous course of neoarsphenamine some months before, followed by a period in which no treatment was given.

In 1 other patient further dilatation of the pupils and breaking of synechiae were slow and incomplete after heat therapy. The synechiae had been present for one month, and no previous antisyphilitic treatment had been given.

A third patient showed only temporary subjective improvement and no objective improvement after two treatments. A moderately severe reaction occurred from each treatment, and the fever therapy was discontinued. The patient had had some antisyphilitic treatment for one year. For six weeks prior to admission to the hospital severe iridocyclitis and corneal ulcers had been present, which were unaffected by chemotherapy. After this discouraging experience with the two heat treatments, a course of tuberculin was started, because the patient had a positive tuberculin reaction and hilar lymph nodes were demonstrated in a roentgenogram. The response to six injections of tuberculin (purified protein derivative) was amazingly good. The patient has continued to improve slowly after the initial rapid subjective and objective improvement.

A fourth case may be mentioned because of the strikingly rapid response. The patient had a large solitary syphilitic nodule on the temporal portion of the right iris. Two days after the second treatment there was absolutely no elevation at the site of this nodule, and the eye was no longer injected, painful or photophobic. Injections of neoarsphenamine were started, and the patient returned for weekly

fever treatments after discharge from the hospital. There has been no recurrence of the iritis.

On comparing the results for these patients with those for the patients in the clinic who were not eligible to receive fever therapy because of nonresidency or who declined the treatment, one can note a distinctly shorter course and fewer permanent synechiae in those given fever therapy. The resultant visual acuity was approximately the same for the two groups. Those patients who are seen and treated early respond much more quickly and more completely.

Syphilitic Atrophy of the Optic Nerve.—Neymann and Osborne [36a] reported 6 cases of far advanced atrophy of the optic nerve in which electropyrexia was used. Two of the patients became blind; the condition in 2 was unchanged, and 2 showed improvement. Culler and Simpson [30] were able to demonstrate practically no change in visual acuity or in the visual fields in 14 cases during a period of twenty months' observation.

Menagh [37] reported improvement only in those cases in which cellular infiltration of the nerve was present. According to Culler and Simpson, neuritis as a secondary manifestation of syphilis responded well, and neuritis associated with syphilis of the nervous system was arrested; they reported 4 cases of the former and 10 of the latter. Clark [38] studied 12 cases of syphilitic atrophy of the optic nerve in which malaria therapy was employed; he attributed improvement in 8 of these to fever, vasodilatation and stimulation of the reticuloendothelial system.

Report of a Case of Atrophy of the Optic Nerve.—The patient was seen first in the ophthalmic clinic, where a diagnosis of atrophy of the optic nerve, probably due to tabes, was made. Examination of blood and spinal fluid gave positive results, and the colloidal gold curve was of the tabetic type. The diagnosis was confirmed in the neurologic clinic. The vision in the left eye was 20/30; that in the right eye was limited to perception of light. The pupils were both small and reacted but slightly to light. The left visual field was limited to an irregular angulated central area. The right visual field could not be taken. After six fever treatments no change was noted in the peripheral field, in the serologic reaction of the blood and spinal fluid or in the colloidal gold curve. The patient stated that he no longer has pains in the legs and is perhaps less ataxic. Vision remains the same.

In this case it is assumed that the improvement in the lancinating pains in the legs was due to a subsidence of the radiculitis.

36a. Neymann, C. A., and Osborne, S. L.: The Development of Hyperpyrexia, Arch. Phys. Therapy **15**:149 (March) 1934.

37. Menagh, F. R.: Treatment of Syphilis with Hyperpyrexia, with Observations on the Prognosis of Optic Atrophy, Am. J. Syph., Gonor. & Ven. Dis. **21**:609 (Nov.) 1937.

38. Clark, C. P.: Rôle of Malaria in Control of Atrophy of the Optic Nerve Due to Syphilis: A Study of Twelve Cases, Arch. Ophth. **15**:250 (Feb.) 1936.

TABLE 3.—*Data on Eleven Cases of Syphilitic Iridocyclitis*

Patient	Age, Years	Extent of Involvement*	Previous Anti-syphilitic Treatment	Duration of Treatment Prior to Fever Therapy	Posterior Synechiae	Keratic Precipitates	Number of Treatments	Total Hours of Treatment	Vision on Admission	Final Vision†	Recurrence
L. A.	39	O. U.	None	14 days	From 10 to 12; broad and rigid	++	5	17	Hand movements and 20/200	Reading vision in each eye	No
M. B.	24	O. U.	None	6 wk.	From 8 to 10; broad and rigid	++	3	9	20/200 and 20/200	Reading vision in each eye	No
W. U.	24	O. U.	None	4 wk.	From 3 to 5; delicate	+	3	7	20/200 and 20/20	20/20 and 20/20	No
S. M.	26	O. D.	None	8 days	Few; delicate	+	4	17	20/40 and 20/40	20/20 and 20/20	No
J. B.	22	O. U.	4 mo.	14 days	From 8 to 10; broad and rigid	—	4	16	20/20 and 20/65	20/20 and 20/65	No
W. D.	24	O. D.	None	7 days	1; delicate (nodular iritis)	+	2	8	20/200 and 20/30	20/20 and 20/20	No
N. T.	37	O. D.	1 wk.	16 days	3; delicate	+	2	10	20/70 and 20/30	20/20 and 20/30	No
W. B.	31	O. U.	None	1 mo.	8; broad and rigid	+++	10	50	20/200 and 20/200	20/20 and 20/30	No
H. C.	39	O. U.	6 mo. irreg.	2 mo.	From 8 to 10; small but rigid each eye	++	2	4	20/70 and 20/200	20/70 and 20/200	Yes
R. O.	19	O. U.	None	3 wk.	6; narrow	+	7	31	Hand movements in each eye	20/30 and 20/30	No
F. N.	24	O. D.	None	2 wk.	4; broad and rigid	+++	3	13	Hand movements and 20/20	20/70 and 20/20	No

* O. U. indicates each eye; O. D., the right eye, and O. S., the left eye.
† Reading vision is equivalent to about 20/40.

MENINGOVASCULAR SYPHILIS

Reports of several investigators indicate that meningovascular syphilis of the nervous system responds readily to fever therapy, especially when combined with chemotherapy.

Theoretically, during the early stage or during the stage of actual inflammatory reaction in the nerve tissue, this should be the treatment par excellence, when combined with chemotherapy.

The case reported here, in which treatment was incomplete, is included for the sake of completeness of this report and to indicate that good results are anticipated in such cases in the future.

Report of a Case of Meningovascular Syphilis with Paralysis of the Extrinsic Ocular Muscles.—A patient with meningovascular syphilis and paralysis of the extrinsic ocular muscles was treated with heat combined with the administration of neoarsphenamine. Only one treatment had been given, when an infection of the upper part of the respiratory tract developed. The patient has not returned for more fever therapy. She has continued antisyphilitic therapy and improved satisfactorily. Vision is 20/20 in the right eye and 20/40 in the left eye.

No conclusion can be drawn from this case.

MENINGOCOCCIC ABSCESS OF THE VITREOUS

There is a definite theoretic reason for employing fever therapy in cases of meningococcic abscess of the vitreous. The meningococcus is biologically similar to the gonococcus and is known to be susceptible to high temperatures.

Moench [39] recently reported the in vitro heat sensitivity of fifteen strains of meningococcus within the range of therapeutic temperatures. At temperatures of from 40 to 42 C. (104 to 107.6 F.) all but one strain showed reduction of growth within from five to seven hours. Five strains were either destroyed or reduced in five hours or less, seven strains showed moderate reduction; two showed only slight reduction, and one was not affected in seven hours at a temperature above 41 C. (105.8 F.). It would therefore seem advantageous to use several five or six hour treatments at from 41 to 42 C. It would also seem best to start treatment at the earliest possible time, depending on the patient's general condition. Meningococcemia and meningitis have also been treated by fever therapy, but not enough data are available to draw any conclusions.

A year ago Dunphy [40] reviewed the ocular complications of cerebrospinal meningitis in a most thorough manner. Intraocular injection of

39. Moench, L. M.: A Study of the Heat Sensitivity of the Meningococcus in Vitro Within the Range of Therapeutic Temperatures, J. Lab. & Clin. Med. **22**:665 (April) 1937.

40. Dunphy, E. B.: Ocular Complications of Cerebrospinal Meningitis, Arch. Ophth. **15**:118 (Jan.) 1936.

specific antiserum was advocated. No mention of fever therapy was made for any of the complications described.

Report of Two Cases of Meningococcic Abscess of the Vitreous.—Two patients with endophthalmitis developing as a complication of epidemic meningitis were treated by fever therapy in the division for contagious diseases at the Cincinnati General Hospital. One of the patients had no perception of light in the involved eye. The other had only perception of light. It was not thought possible to recover more vision for these patients. However, because such eyes usually remain irritable, injected, photophobic and blind, with unsightly globes, often progressing to phthisis bulbi, it was decided to try fever therapy in the hope that the inflammatory process would be quieted earlier and perhaps remain so. The first patient had marked iridocyclitis and keratic precipitates, and the conjunctival smear was positive for meningococci. Five treatments, two of five hours and three of three hours' duration, were given. The shorter treatments were given because temperature was not being sustained at a sufficiently high level. The conjunctival smears became negative. The generalized injection of the globe progressively decreased. The hypopyon and keratic precipitates, which had been receding slowly prior to treatment, disappeared rapidly after the first two sessions. The yellow pupillary reflex remained dull until the fourth treatment. Then it became brighter, and the inflammatory reaction on the vitreous seemed to be "fixed." Four months ago it was found advisable to enucleate the phthisical eye.

The second patient had but one treatment before being sent home. She stated that she could open her eye better and had less fear of light while in the fever machine, but that in a few hours it again hurt her to open her eye. No objective change could be noted.

PHLYCTENULAR KERATOCONJUNCTIVITIS

Only one report could be found in the literature on the use of artificial fever[8] for the treatment of phlyctenular keratoconjunctivitis. Nonspecific protein therapy has probably been employed, but is not mentioned in the standard textbooks on ophthalmology.

In the average case the disease responds well to symptomatic local treatment plus a regimen intended to improve the general nutrition. There is, however, a small percentage of cases in which visual acuity is markedly impaired, even to the point of blindness, because of the formation of corneal scars. Many patients have repeated attacks, and in others the condition persists for long periods, during which the patient is entirely incapacitated because of the severe pain and blepharospasm due to ulceration at the site of the phlyctenae.

Subjective relief in cases in which the condition is severe and of long duration and the prevention of marked corneal scarring are the aims of radical treatment.

It is recommended that fever therapy be reserved for use in cases of severe involvement, with the intent of relieving subjective symptoms and preventing permanent visual damage.

Report on Four Cases of Phlyctenular Keratoconjunctivitis.—All 4 cases of phlyctenular keratoconjunctivitis were typical, and in all the patients gave positive

reactions to tuberculin. In 2 there was evidence of involvement of the hilar lymph node on roentgenographic examination. The condition developed in 1 case three months after gonorrheal conjunctivitis, with the residual corneal scarring. The specific conjunctivitis had responded to routine local and systemic treatment. The patient, aged 22 months at the time of heat treatment, was the youngest in the series and tolerated the treatments well.

After treatment with the hypertherm, all 4 patients had marked subjective and less marked objective improvement. However, it was thought that healing was effected sooner than usual. The resultant scars were all small and macular in type. Local treatment consisted of the use of atropine and hot compresses; general treatment consisted of a diet high in calories and vitamins and the administration of cod liver oil.

CORNEAL ULCERS

Whitney [41] reported the successful treatment of corneal ulcers with the Kettering hypertherm. The series of patients at the Cincinnati General Hospital included 2 with corneal ulcer. Reports of these cases follow:

The first patient, a Negro boy aged 12 years, had had purulent dacryocystitis for many months prior to sustaining a corneal abrasion from a foreign body. Ulceration followed the injury. The use of atropine, hot compresses and irrigations with antiseptic solutions failed to alter the course of the ulcer.

Treatments with the hypertherm were started. The ulcer cleared rapidly, and after healing only a small leukoma remained. Eight treatments were given. Final vision was 20/30.

The second patient was treated for a chronically recurring ulcer on the right cornea. One year previously the patient had had a bilateral corneal condition, the nature of which was not known, which left a leukoma on the left cornea. The site of the ulcer on the right cornea was the same as that of the original process. The eyeball showed marked injection of the ciliary body and was irritable. Local treatment had given only partial and temporary improvement.

Three fever treatments were given, and the response was surprisingly good. The ulcer healed rapidly, leaving a smaller scar than had been anticipated. Apparently there has been no recurrence. The patient was followed for three months and then stopped coming to the clinic even for observation. Vision was preserved in this eye (20/30).

At the hospital most of the patients with corneal ulcer have been treated with injections of typhoid vaccine or antigen, sometimes combined with paracentesis. The results have been good, so that only 2 patients have been treated with fever therapy.

CONJUNCTIVITIS DUE TO GRAM-POSITIVE DIPLOCOCCI

One case of conjunctivitis due to gram-positive diplococci is presented.

A child 4 years of age was admitted to the hospital with severe purulent conjunctivitis. The lids were swollen, and the cornea was uninvolved. Smears

41. Whitney, E. L.: Artificial Fever in the Treatment of Corneal Ulcer and Acute Iritis: Preliminary Report, J. A. M. A. **104**:1794 (May 16) 1935.

showed gram-positive diplococci. Three seven-hour treatments and one four-hour treatment were given. The conjunctival discharge increased after the first two treatments and then subsided rapidly, the smears becoming negative. When the patient was dismissed from the hospital, the lids, conjunctiva and cornea were normal. Vision was 20/20 in each eye. Unfortunately, the thermal death point of this particular organism was not determined.

ALLERGIC CONJUNCTIVITIS

The series of 50 cases presented here includes 1 case of allergic conjunctivitis.

A Negro boy of 6 years, with severe, resistant allergic conjunctivitis, which had not responded to treatment in the "allergy clinic," was given twenty-three hours of fever therapy. There was no known precedent for this treatment and no apparent reason for using it. Symptomatic relief was not obtained, and no objective improvement resulted from the three treatments. Visual acuity was not altered by the conjunctivitis.

NONSPECIFIC UVEITIS

Two patients with uveitis of unknown origin were treated with heat. A thorough search for all possible causes was made and repeated, without success.

The first patient had two treatments, with only temporary subjective relief. No change could be seen in the amount of injection or in the amount of corneal precipitates or vitreous exudates. The patient had also failed to respond to injections of typhoid antigen given elsewhere and has shown only a slight tendency to improve since the onset six months previously. It is felt that if more fever therapy had been accepted, some improvement might have resulted. The patient is now able to see hand movements at 4 feet (122 cm.).

The second patient had bilateral severe iridocyclitis, which had not responded to various other methods of treatment during the preceding four months. Fever therapy was tried as a last resort. Only temporary subjective relief was obtained after four treatments. No objective improvement was noted. The condition in this case has progressed to practical blindness despite all treatment.

CONJUNCTIVITIS WITH MARGINAL CORNEAL ULCERS

The present series of cases includes 1 of conjunctivitis with a marginal corneal ulcer.

The patient had been treated by several excellent ophthalmologists prior to admission to the clinic. The course of the conjunctivitis had not been determined, despite two thorough examinations. There was no improvement after one session of fever treatment, lasting three hours at a temperature of from 105 to 106 F., and further treatments were refused because a marked herpes labialis developed and because no subjective improvement had been experienced. When mycelia were finally demonstrated on direct smear, instillations of a solution of acriflavin were prescribed, and a remission of two months' duration resulted. Recently a relapse occurred in this case, and a diagnosis of Mooren's ulcer was made elsewhere.

TUBERCULOUS KERATITIS AND IRIDOCYCLITIS

One patient with tuberculous keratitis and iridocyclitis was subjected to fever therapy.

The patient had bilateral persistent keratitis, with diffuse scar formation. Iridocyclitis with secondary glaucoma had developed in one eye. The condition was considered hopeless, but two fever treatments of three and a half hours' duration at from 106 to 108 F. were given; only temporary subjective and no objective improvement occurred in either eye. The inflamed eye was removed because it was blind and painful. Microscopic sections showed primary tuberculosis of the cornea. Two years later the patient returned for enucleation of the second eye, which was then blind and painful. Sections of this eye did not show positive microscopic evidence of tuberculosis.

COMPLICATIONS OF FEVER THERAPY

Not all complications of fever therapy have been observed in the series of cases presented here, but all have been observed at the Cincinnati General Hospital, in the department of fever therapy.

Complications are infrequent and for the most part easily handled. Some of the distressing complications noted earlier in the history of fever therapy have been abolished by careful preparation of the patient with the administration of calcium preparations, saline solution and dextrose and the administration of a minimal amount of sedatives.

The following complications have been observed in this series:

1. Nausea and vomiting. This may be delayed until from one half to one hour after treatment and is best prevented by avoiding the use of morphine and by refraining from overeating and the ingestion of drinks that are too cold.

2. Tetany. This may be avoided by the routine administration of calcium lactate or calcium gluconate and saline solution.

3. Muscle cramps. These may be avoided by the ingestion of saline solution, or by the intravenous injection of it if necessary. Numbness and tingling are not infrequently complained of during periods of induction and decline of fever.

4. Heat exhaustion. The temperature may continue to rise, and the blood pressure continue to drop. (In 1 case it rose to 109 F. in two hours.) If this occurs the patient is removed from the box and rubbed with ice and towels. Saline solution and dextrose are given intravenously. The temperature then drops, and the blood pressure returns to normal after about two hours.

5. Shock—vasomotor collapse without a continued rise in temperature. If this occurs, saline solution and dextrose are given intravenously, and stimulants (coramine [a 25 per cent solution of pyridine beta-carbonic acid diethylamine] or a similar drug) are administered.

TABLE 4.—*Data on Group of Fifty Cases of Ocular Disease*

Patient	Race	Sex	Age, Years	Diagnosis	Extent of Involvement†	No. of Treatments	Total Hours of Treatment	Temperature Range, F.	Subjective Improvement	Objective Improvement	Final Visual Acuity‡
A. A.	White	M	20	Gonorrheal conjunctivitis	O. S.	3	2½	105-107	Marked	Marked	20/20 and 20/15
J. D.*	Negro	M	6	Gonorrheal conjunctivitis with ulcer	O. S.	3	16	105-107	Marked	Marked	Reading vision
R. T.	White	M	53	Gonorrheal conjunctivitis with ulcer	O. D.	4	5½	105-107	Marked	Marked	20/30 and 20/20
F. T.	White	M	9	Gonorrheal conjunctivitis	O. U.	6	19½	103-106	Marked	Marked	20/30 and perception of light
J. L.	Negro	M	22	Gonorrheal conjunctivitis with ulcer	O. S.	5	15	105-106	Marked	Marked	20/30 and 20/30
G. F.	Negro	M	9	Gonorrheal conjunctivitis	O. S.	2	11	105-108	Marked	Marked	20/30 and 20/30
B. W.	Negro	F	4	Gonorrheal conjunctivitis	O. U.	2	6	105-106	Marked	Marked	20/20 and 20/20
M. B.	Negro	F	9	Gonorrheal conjunctivitis with ulcer	O. S.	2	9½	105-106	Marked	Marked	20/20 and 20/20
P. H.	White	M	22	Gonorrheal conjunctivitis; perforation	O. U.	9	38	105-107	Marked	Good; slow	20/20 and perception of light
R. J.	Negro	F	4	Gonorrheal conjunctivitis	O. D.	1	5	106-107	Marked	Good; burned	20/20 and 20/20
W. C.	White	M	13	Gonorrheal conjunctivitis	O. U.	2	6	104-107	Marked	Marked	20/20 and 20/20
E. P.	White	M	25	Gonorrheal iridocyclitis	O. S.	3	13	105-106	Marked	Marked	20/20 and 20/20
L. L.	White	F	10	Interstitial keratitis	O. U.	6	28	105-106	Marked	Marked	Reading vision in each eye
M. W.	White	F	10	Interstitial keratitis	O. D.	3	11½	105-106	Marked	Marked	20/40 and 20/30
G. C.	White	F	12	Interstitial keratitis	O. U.	12	47	103-106	Marked	Slight	20/50 and 20/50
E. A.	White	M	5	Interstitial keratitis	O. S.	9	27	105-107	Marked	Marked	Reading vision in each eye
L. T.*	Negro	F	9	Interstitial keratitis	O. U.	11	37½	105-107	Marked	Marked	20/50 and 20/65
L. J.	White	M	8	Interstitial keratitis	O. U.	6	12	103-106	Marked	Marked	20/20 and 20/20
El. W.	Negro	F	9	Interstitial keratitis	O. U.	13	48	103-107	Marked	Marked	20/20 and 20/40
M. L.	Negro	F	12	Interstitial keratitis	O. U.	8	32	103-106	Marked	Moderate	20/20 and 20/20
Ea. W.	Negro	F	12	Interstitial keratitis	O. S.	6	28	105-106	Marked	Slight	20/25 and 20/25
J. R.	Negro	M	9	Interstitial keratitis	O. D.	4	20	105-106	Marked	Moderate	Reading vision and 20/30
L. A.	White	M	39	Syphilitic iridocyclitis	O. U.	5	17	104-106	Marked	Moderate	Reading vision in each eye
M. B.	White	F	24	Syphilitic iridocyclitis	O. U.	3	9	105-106	Marked	Moderate	20/20 and 20/30.
W. O.	Negro	M	24	Syphilitic iridocyclitis	O. U.	3	7	105-106	Marked	Marked	20/20 and 20/20
S. M.	Negro	F	26	Syphilitic iridocyclitis	O. D.	4	17	105-106	Marked	Marked	20/40 and 20/40
J. B.	Negro	M	22	Syphilitic iridocyclitis	O. U.	4	16½	105-107	Slight	Fair	20/20 and 20/65
W. D.	Negro	F	24	Syphilitic iridocyclitis	O. D.	4	16½	105-106	Marked	Marked	20/20 and 20/20
N. T.	White	F	37	Syphilitic iridocyclitis	O. D.	2	10	105-106	Marked	Marked	20/20 and 20/30
W. B.	White	M	31	Syphilitic iridocyclitis	O. U.	10	50	105-106	Marked	Moderate	20/30 and 20/30
H. C.	Negro	F	39	Syphilitic iridocyclitis	O. U.	2	4	103-107	Temporary	None	20/40 and 20/40
R. C.	Negro	M	19	Syphilitic iridocyclitis	O. U.	7	31	103-106	Moderate	Slow	20/30 and 20/30
F. N.	Negro	F	24	Syphilitic iridocyclitis	O. D.	3	13½	105-106	Marked	Moderate	Reading vision and 20/20
C. B.	White	M	..	Syphilitic atrophy of the optic nerve	O. U.	12	50	104-106	None	None	Perception of light and 20/30
P. E.	Negro	F	26	Meningovascular syphilis with paralysis of ocular muscles	O. S.	1	5	105-106	None	None	20/20 and 20/40
D. E.	White	F	7	Abscess of vitreous (meningococcic)	O. D.	6	18	103-107	Moderate	Slight	No vision and 20/20
N. H.	White	F	11	Abscess of vitreous (meningococcic)	O. D.	1	3	105-106	Temporary	None	Perception of light and 20/20
B. D.*	Negro	F	5	Phlyctenular keratoconjunctivitis	O. U.	3	25	105-107	Marked	Moderate	Reading vision in each eye
E. E.*	Negro	F	2	Phlyctenular keratoconjunctivitis	O. U.	8	36	105-107	Marked	Moderate	Reading vision in each eye
P. P.*	White	M	13	Phlyctenular keratoconjunctivitis	O. D.	3	16	101-106	Marked	Marked	20/25 and 20/25
I. S.	Negro	M	7	Phlyctenular keratoconjunctivitis	O. U.	2	6	104-106	Marked	Marked	20/20 and 20/20
O. H.	Negro	M	9	Tuberculous parenchymatous keratitis	O. S.	7	23	103-106	Marked	Marked	20/25 and 20/25
C. W.	White	M	11	Corneal ulcer	O. D.	2	8	105-106	Marked	Marked	Reading vision in each eye
E. S.	Negro	M	12	Corneal ulcer	O. D.	6	25	104-107	Marked	Marked	20/30 and 20/20
J. H.	Negro	M	4	Pneumococcic conjunctivitis	O. S.	4	26	106-107	Marked	Marked	20/20 and 20/20
L. D.	Negro	M	6	Allergic conjunctivitis	O. U.	3	24	104-105	None	None	20/30 and 20/30
J. F.	White	M	26	Nonspecific uveitis	O. S.	2	8	105-107	Temporary	None	20/20 and counting of fingers at 2 feet
B. S.	Negro	F	40	Nonspecific uveitis	O. U.	4	16	105-106	Temporary	None	No vision and perception of light
S. W.	Negro	M	34	Conjunctivitis, with marginal corneal ulcer	O. U.	1	3	105-106	Temporary	None	20/20 and 20/20
A. S.*	White	F	30	Tuberculous keratitis and iridocyclitis	O. U.	2	7	106-108	Temporary	None	No vision in either eye

* The patients whose initials are thus indicated were treated by Dr. R. H. Miller and by Dr. M. H. Metz[8] prior to my participation in this field. They have permitted me to include the same case reports in this series.

† O. U. indicates each eye; O. D., the right eye, and O. S., the left eye.

6. Hysteria and delirium. These complications are noted most frequently in patients with gonorrheal arthritis for some unknown reason. Their occurrence is not serious.

7. Burns. Patients are covered with blankets in the box to prevent their being burned. Occasionally skin over bony prominences not in contact with anything becomes burned. In a Negro girl aged 4 years, a burned area developed on the skin covering a large umbilical hernia. Healing was normal in rate.

8. Collapse. This is seen more frequently in cases of congenital syphilis, but it is not serious, lasting only a few minutes. The patient becomes pale; the pulse becomes weak, and the blood pressure falls. In no case has it been severe enough to necessitate stopping all treatment. Failure to induce the desired temperature is sometimes encountered. A given patient may fail to get a consistent rise in temperature at one session and react perfectly the next. No reason for this is known. It has also been noted that fever is harder to attain and maintain in the Negro and in the patient who have worked for long periods in extremely hot places.

COMMENT

The treatment in the present series of cases has been administered on the theory that the more acute the ocular inflammation, the more frequent should be the fever treatments. This plan seems to have served well in this limited number of cases. Treatments were given every third day, if possible, depending on the patient's general condition and reaction. Five-hour sessions with temperature maintained from at 105 to 107 F. were found to be most satisfactory. Maintaining the same temperature for only one hour, even though repeated every day or every other day, proved to be of little value.

There has been no fixed standard for the total number of treatments. The patients were treated as frequently as possible, and treatments were continued until improvement occurred, or until it was felt that the patient was refractile to the treatment. A few patients have returned each week for from four to six weeks after discharge from the hospital for supplementary treatments after the acute inflammatory symptoms had subsided.

It is believed that more frequent treatments are advantageous and that an elastic standard of the total hours of fever to be induced must be maintained, in order to meet the need of each individual case without subjecting the patient to more fever than is necessary. However, I believe that some minimum number of hours could and should be set for the acute and more or less chronic stages of each of the ocular diseases treated. This is most feasible in the various stages of syphilis. Chronic lesions may well be treated once a week for ten or more treat-

ments, as had been done by other investigators. The establishment of a standard procedure will require the consideration of large numbers of cases as reported by different observers who use both identical and different intervals and total fever hours of treatment. When the thermal death point of the causative agent is known, the dosage is easier to estimate, but the clinical course must determine the management in each individual case.

Some opposition is often encountered when fever therapy is suggested to the patient. However, after one session little difficulty is had in getting the patient to continue. Fear of the machine and of the fever are dispelled, and subjective relief in acutely inflamed eyes with photophobia, blepharospasm, pain and excessive lacrimation is usually noticeable after the first or second treatment.

The modus operandi of fever therapy is as yet unexplained. "Stimulation of body defense mechanism" is a vague and indefinite term. No better explanation is offered for the action of injected nonspecific protein and malaria. Numerous comparative studies have appeared in the literature advocating one or another method in preference to other fever-producing agents. Such studies are of great value in determining relative merits. The method is being sought which produces the best end result with the least damage to the patient and which is most easily employed.

Although this paper is a report of observations made on patients treated in the Kettering hypertherm only, a few comparisons have been made with results observed or claims made by others using injections of nonspecific proteins and of malarial organisms.

One cannot help feeling that perhaps both of the latter forms of treatment may add to, or cause to be produced in, the body something more than an elevation of body temperature. This feeling is accentuated by the observation that injections of nonreactive typhoid antigen often give excellent therapeutic results and by reports that patients inoculated with malarial parasites who do not get chills and fever are improved (patients with dementia paralytica). For these reasons one must not allow oneself to become too enthusiastic over mechanically induced hyperpyrexia. It remains for those interested in this form of therapy to report their few cases accurately until reports of a sufficient number of cases are collected for comparison of the results with the various methods of treatment.

I would suggest the possibility that protein substances may be liberated in the course of any fever, regardless of its origin, which produce a reaction in the body similar to that produced by injected nonspecific proteins.

DISADVANTAGES OF THERAPY WITH THE KETTERING HYPERTHERM

The following disadvantages have been observed from the use of the Kettering hypertherm:

1. The treatment is definitely strenuous. While complications are few and mortality low, this treatment is not unattended by fear, fatigue and some danger of collapse and heat stroke.

2. Constant nursing care is absolutely necessary while the patient is in the fever machine. One nurse is required for each patient, whereas in a ward one nurse can care for many patients being treated by injections of foreign protein or of malarial parasites.

3. The machine itself is expensive, and the cost of operation is fairly high.

4. Fever machines are not accessible to many practicing physicians. This is as it should be until this form of treatment is out of the experimental stage. However, other fever-producing agents are accessible to almost every one.

ADVANTAGES OF THERAPY WITH THE KETTERING HYPERTHERM

The Kettering hypertherm offers the following advantages:

1. High temperatures are readily attained and maintained for definite lengths of time, as desired.

2. The temperature is easily controlled.

3. No new disease is added to the patient as opposed to malaria therapy.

4. The morbidity and mortality are less with fever therapy than with malaria.

5. Hospitalization is often not necessary. A patient can be treated as an outpatient, or at most kept overnight after a treatment. Malaria therapy requires much care during the induced disease and some care during convalescence.

6. The action of heat therapy is rapid. Response is quickly seen and I believe that failure to obtain a response can be told after a few treatments. Treatments can be given three times a week in acute processes and weekly in more chronic diseases.

7. Subjective relief is obtained early and consistently in cases of acute ocular inflammation and in some cases of subacute ocular inflammation (especially interstitial keratitis and iridocyclitis). Relief of photophobia and blepharospasm allows better examination and local treatment of the involved eye.

8. Any other treatment, local or general, directed toward ocular or systemic disease may be given concurrently. Antisyphilitic therapy is considered more effective when combined with fever therapy than

when used alone. When malaria therapy is used antisyphilitic treatment must be discontinued lest it kill the fever-producing organism. Typhoid and other nonspecific proteins can be injected between fever treatments. This serves to satisfy those who feel that the body's defense mechanism is better stimulated in this way.

SUMMARY AND CONCLUSIONS

The Kettering hypertherm is a valuable agent for the treatment of several ocular diseases.

It is most efficacious in the treatment of gonorrheal conjunctivitis, syphilitic interstitial keratitis and syphilitic iridocyclitis.

Much more investigation is necessary before definite conclusions can be drawn concerning its relative value, its indications and the number and frequency of necessary treatments.

It is suggested that persons with acute active inflammations and gonorrheal conjunctivitis be treated as frequently as they can tolerate hyperpyrexia. Less frequent treatments may be used for those with more chronic conditions.

It is suggested that corneal ulcer, severe phlyctenular keratoconjunctivitis, metastatic meningococcic endophthalmitis and active neuritis of the optic nerve (especially of the syphilitic type) be given more study to determine the value of fever therapy for these conditions.

441 Vine Street.

Correspondence

INSTRUMENTS FOR TREATMENT OF STRABISMUS

To the Editor:—In the December 1937 issue of the ARCHIVES the surgical treatment of strabismus is reviewed by Dr. Maynard C. Wheeler of New York. On page 1005 Dr. Wheeler states: "One of the newer and more original contributions to the surgical treatment of strabismus is the method for shortening a muscle by means of the myocampter, perfected by Barraquer."

I have never seen Barraquer's myocampter, but Dr. Wheeler's description of the instruments and the procedure is almost identical with that of the instruments and procedure of the late Dr. H. H. Briggs, of Asheville, N. C.

In the *Transactions of the Section on Ophthalmology of the American Medical Association* for 1909 and again in a paper read at the New York meeting of the American Medical Association in June 1917 and published in the *Transactions* of that year (pages 260-270), Dr. Briggs described his method of tendon shortening by the use of the silver clip. The instruments for this procedure have been on sale by Meyrowitz for more than twenty years.

Dr. Wheeler's review of the literature does not go back farther than 1930. In justice to American ophthalmologists, however, I feel that Barraquer's myocampter should not be called "one of the newer contributions," and it is doubtful in my mind whether it should be called "original."

This letter is not intended in any degree as a reflection on or as a criticism of Dr. Wheeler's review. His article reviews only the recent literature and is, in my judgment, one of the best that I have seen on the surgical treatment of strabismus.

WALTER J. BRISTOW, M.D., Columbia, S. C.

OCULAR MANIFESTATIONS OF ENDOCRINE DISTURBANCE

Dear Dr. Lemoine:—I enjoyed reading your article on "Ocular Manifestations of Endocrine Disturbance" in the ARCHIVES OF OPHTHALMOLOGY (**19: 184** [Feb.] 1938).

I should appreciate an explanation of your statement (page 188) that calcium disturbance may produce cataract.

How does an increase or decrease of calcium in the blood affect the transparency of the lens? As a matter of fact, the chemistry of the lens remains the same at all ages until opacification sets in.

Your statement that there is a close association between cataract and parathyroid tetany, while true, requires a rational explanation. It is not the mystic hormonal activity of the parathyroid gland that causes cataract in some cases of parathyroid tetany but the direct injury to the lens due to a concussion of the lens during the convulsion. The

same is true of epileptic and eclamptic convulsions, which are associated with a higher incidence of cataract formation.

No convulsion, no cataract. Not the calcium but the concussion causes the cataractous formation.

AARON BRAV, M.D., Philadelphia.

Dear Doctor Brav:—Your point is well taken, as there is no definite chemical evidence that calcium disturbance plays a part in altering the calcium content of the lens. That was the reason for qualifying the statement with the word "may." However, one must bear in mind that many problems of nutrition and biochemical processes are not yet fully understood or explained and that by altering the nutrition and intraocular chemistry cataract could develop without altering the calcium content of the lens. The incidence of calcium deficiency in juvenile and presenile patients with cataract but no family history of the condition is too frequent for its occurrence to be entirely a coincidence. Consequently, I concluded that calcium deficiency may produce cataract.

ALBERT N. LEMOINE, M.D., Kansas City, Mo.

News and Notes

EDITED BY W. L. BENEDICT

SOCIETY NEWS

Ophthalmological Society of the United Kingdom.—The annual congress of the Ophthalmological Society of the United Kingdom was held at the headquarters of the Royal Society of Medicine, 1 Wimpole Street, London, W. 1 on April 28 to 30, 1938, Dr. Gordon M. Holmes, C. M. G., C. B. E., F. R. S., presiding.

The program opened with a discussion on the differential diagnosis of the causes of exophthalmos. Contributors to this discussion were as follows: Mr. R. Foster Moore (ophthalmic aspects), Mr. T. Cawthorne (otolaryngologic aspects), Dr. Russell Brain (medical and neurologic aspects), Mr. J. H. Doggart (differential diagnosis in children) and Mr. Pochin (lid retraction and exophthalmos in exophthalmic goiter). The following papers were presented:

"A Case of Glioma Retinae, with Special Reference to the Mode of Spread." Mr. S. Spence Meighan and Mr. I. C. Michaelson.

"A Case of Meningocele of the Orbit and the Diagnosis from Other Cystic Tumors." Mr. M. H. Whiting.

"Remarks on Ophthalmic Gout." Mr. L. H. Savin.

"A Contribution to the Pathology of Angioid Streaks." Mr. F. W. Law.

"Abnormal Retinal Correspondence." Miss Cass.

"Some Aspects of the Anatomy of the Optic Nerve Head." Mr. E. Wolff.

"The History of Contact Lenses." Miss Ida Mann.

"Some Observations on Fluid Interchange and Its Bearing on Certain Ophthalmologic Problems." Dr. Douglas Robertson.

"The Osmotic Pressure Equilibrium in Normal and Glaucomatous Eyes." Dr. T. H. Hodgson.

"Detachment of the Choroid." Mr. B. W. Rycroft.

"Vascular Changes in the Retina, Optic Nerve and Kidney: A Clinical and Pathologic Study. Prof. A. J. Ballantyne, Mr. I. C. Michaelson and Mr. J. F. Heggie.

"Associated Lacrimal and Parotid Mixed Tumors." Messrs. J. Pendleton White, I. C. Michaelson and J. F. Heggie.

"Observations on the Treatment of Epiphora." Mr. O. Gayer Morgan.

"A Further Communication on the Etiology and Treatment of Phlyctenular Ophthalmia." Mr. A. Sorsby, Mr. R. Hamburger, Miss Margaret Coveney and Miss Mary E. Nevin.

"Ophthalmic Operations under Evipan." Mr. T. K. Lyle.

"Paraldehyde Analgesia." Dr. E. S. Rowbotham.

"A Series of Operations Under Paraldehyde Narcosis." Mr. Basil Graves.

"Some Problems of Neuromyelitis Optica." Dr. T. R. Hill.

"Direct Measurement of the Axial Length of the Eye in the Living Subject by X-ray." Mr. R. H. Rushton.

"A Melanosome Dispersing Substance in the Blood and Urine in Retinitis Pigmentosa." Dr. E. C. Dax.

"Retinitis Pigmentosa in Rats." Miss D. R. Campbell.

"Notes on Dark Adaptation and a Simple Instrument for Its Investigation." Mr. R. P. M. Haines.

"The Treatment of Tobacco Amblyopia by Acetylcholine." Mr. P. M. Moffatt.

Oxford Ophthalmological Congress.—The twenty-seventh annual meeting of the Oxford Ophthalmological Congress will be held at Keble College, Oxford, on the evening of Wednesday, July 6, and the meetings will be held on the following Thursday, Friday and Saturday, July 7, 8 and 9.

On Thursday morning, July 7, there will be a discussion on "Ocular Palsies, Their Etiology, Diagnosis and Treatment." The discussion will be opened by Dr. Bernard Chavasse, Liverpool, from the ophthalmologic point of view, and by a neurologist.

The Doyne Memorial Lecture will be delivered by Prof. Dr. A. von Szily, emeritus director of the Univ-Augenklinic, Münster, and will be entitled "The Contribution of Pathologic Examinations to the Elucidation of the Problems of Cataract—Morphologic Findings and Changes in the Chemistry of the Lens in Different Cases of Cataract, Their Primary Role, Temporal Sequence and Local Combination."

In addition to the foregoing program, the following papers have already been promised:

"The Relationship Between Intracranial and Intraocular Pressure, and the Treatment of Tabetic Optic Atrophy." Prof. Dr. Hans Lauber, Warsaw, Poland.

Discussion on "Anesthesia in Ophthalmic Surgery," opened by Dr. H. M. Traquair, Edinburgh, Scotland.

"Anatomic Changes in Globes with Primary Detachment of the Retina." Dr. Bernard Samuels, New York.

"Papilledema." Dr. J. A. van Heuven, Utrecht, Netherlands.

"Hungarian Plastic Methods." Dr. Czukrasz Ida, Debrecen, Hungary.

Graduate Meeting in Ophthalmology.—This meeting was held at the Wilmer Ophthalmological Institute of the Johns Hopkins Hospital, May 12 to 14, 1938. The following program was presented:

"The Clinical Problem of Sympathetic Ophthalmia." Dr. Alan C. Woods.

"The Pathology of Sympathetic Ophthalmia and Cutaneous Allergy to Uveal Pigment." Dr. Jonas S. Friedenwald.

"Retinal Tumors." Dr. John M. McLean.

"Exhibition of Moving Pictures of Eye Operations." Dr. R. Townley Paton.

"Exophthalmos and Orbital Tumors." Dr. M. Elliott Randolph.

"Hyperthyroidism and Exophthalmos." Dr. Henry M. Thomas.

"The Surgical Treatment of Exophthalmos and Orbital Tumors." Dr. Walter E. Dandy.

"Slit Lamp Ophthalmoscopy." Dr. Jonas S. Friedenwald.

"Syphilitic Atrophy of the Optic Nerves: Occurrence, Significance and Treatment." Dr. Joseph Earle Moore.

"Visual Field Changes in Syphilitic Optic Atrophy." Dr. Louise L. Sloan.

"The Classification and Etiology of Cataracts." Dr. Clyde A. Clapp.

"The Comparison of the Results of Intracapsular and Extracapsular Cataract Operations." Dr. Angus L. MacLean.

"Ocular Changes in Neurologic Disease." Dr. Frank B. Walsh.

"Demyelinizing Disease." Dr. Frank R. Ford.

"Corneal Dystrophies." Dr. Benjamin Rones.

"Clinical Pathologic Conference." Dr. Jonas S. Friedenwald.

"Ocular and Cutaneous Sensitivity in Ocular Tuberculosis." Dr. Alan C. Woods.

"Recent Advances in Bacteriology and Immunology." Dr. Earl L. Burky.

"Arteriosclerosis." Dr. James Bordley, III.

"Arteriosclerotic Changes in the Fundus." Dr. Jonas S. Friedenwald.

"Lindau's Disease." Dr. Tullos O. Coston.

Philadelphia County Medical Society, Eye Section.—The scientific meeting of the Eye Section of the Philadelphia County Medical Society was held April 7, 1938, at the Philadelphia County Medical Building, Twenty-First and Spruce streets. There was a postgraduate conference in ophthalmology from 7:25 to 8:30 p. m., at which the following papers were presented: "Anatomy and Pathology of the Lacrimal Apparatus," by Dr. Edmund B. Spaeth; "Medical Ophthalmology," by Dr. Wilfred E. Fry, and "Refraction Findings and Effective Glasses," by Dr. Sidney L. Olsho.

At the conclusion of the postgraduate conference a general program was held, at which the following papers were read: "Clinical Case from Wills Hospital" by Dr. J. V. D. Quereau, with Dr. Aaron Barlow as commentator; "Sulfanilamide in Gonorrheal Ophthalmia," by Dr. Harry S. Weaver Jr.; "Clinical Experiences with Sulfanilamide," by Dr. Carroll R. Mullen, and "O'Connor Cinch Operation Simplified" (a colored motion picture), by Dr. M. E. Smukler, with Dr. L. F. Appleman as commentator.

Association for Research in Ophthalmology.—The annual meeting of the Association for Research in Ophthalmology will be held in San Francisco on June 14, 1938. The program follows:

1. "Treatment of Experimentally Produced Exophthalmos with Thyroxin and Other Iodine Compounds." George K. Smelser, Ph.D., New York.

2. "Experimental Studies of the Pathogenicity of Staphylococcus Toxin." Dr. James H. Allen and Dr. A. E. Braley, Iowa City.

3. "Eye Lesions in Experimental Infections with Special Reference to Arthritis." Dr. Conrad Berens, Dr. D. Murray Angevine, Dr. Loren Guy and Dr. Sidney Rothbard, New York.

4. "Studies on the Ocular Fluids; II. The Hexosamine Content." Dr. Karl Meyer, New York.

5. "The Influence of the Central Nervous System on the Pigment Migration in the Retina of the Frog." Dr. H. Burian, Hanover, N. H.

6. "Inclusion Blennorrhea; A Study of the Pathologic Changes in the Conjunctiva and Cervix." Dr. A. E. Braley, Iowa City.

7. "Influence of Dinitrophenol on the Production of Experimental Cataracts by Lactose." Dr. W. E. Borley and Dr. M. L. Tainter, San Francisco.

8. "Glaucoma: Classification, Causes and Surgical Control (Results of Microgonioscopic Research)." Dr. Otto Barkan, San Francisco.

Colorado Ophthalmological ond Otolaryngological Societies.—The sixteenth annual summer graduate course in ophthalmology and otolaryngology, under the auspices of the Colorado Ophthalmological Society and the Colorado Otolaryngological Society, will be given in Denver, July 25 to Aug. 6, 1938. The following guest speakers will participate: in ophthalmology, Dr. Alfred Cowan, of Philadelphia, and Dr. Edwin M. Neher, of Salt Lake City; in otolaryngology, Dr. Oscar V. Batson, of Philadelphia, Dr. Henry B. Orton, of Newark, and Dr. Earl C. Padgett, of Kansas City, Mo.

GENERAL NEWS

Summer Course in Ophthalmology and Otolaryngology.—The thirteenth intensive European summer course in ophthalmology and otolaryngology, under the direction of Dr. George W. Mackenzie, of Philadelphia, will be given in Vienna, Austria, in July. Study in Vienna from July 4 to July 31 will be preceded and followed by a few days of sightseeing in Italy.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Cornea and Sclera

CYCLIC OCCURRENCE OF CHRONIC EDEMA OF THE CORNEA: REPORT OF A CASE. E. E. BLAAUW, Klin. Monatsbl. f. Augenh. **98:** 665 (May) 1937.

Blaauw reports a case resembling that reported by V. Haemmerli (*Klin Monatsbl. f. Augenh.* **97:** 745 [Dec.] 1936). Blaauw's patient complained of indistinct vision accompanied by colored rings appearing around lights, which he observed after arising and during dressing. These phenomena began disappearing about 2 o'clock in the afternoon, and vision was normal in the evening. The condition lasted for one-half year, with varying intensity and duration. No symptoms of glaucoma were noted during a period of observation of one and one-half year, and vision remained normal most of this time. Tonometric tests were omitted after a minute vacuolization was observed with the slit lamp in the epithelium and in the parenchyma of the cornea. About eight months later the patient returned. His eye was irritated, since he had shoveled snow that morning. Vesicles in the epithelium of the cornea were visible, which changed in size and location in the course of treatment. Repeated bursting of vesicles prompted Blaauw to scrape off the loose epithelium. It came off readily and regenerated slowly, the process resembling the course of acute herpes zoster; the eye was painful, and the lids became edematous at times. Treatment with pontocaine and acetylsalicylic acid, and instillation of cod liver oil later, furthered recovery. The cause of the disease was an infection with the virus of herpes, in Blaauw's opinion.

K. L. STOLL.

General Pathology

A VESSEL-CARRYING LAYER OF CONNECTIVE TISSUE BETWEEN THE PIGMENT EPITHELIUM AND THE LAMINA VITREA. W. REICHLING and F. KLEMENS, Arch. f. Ophth. **137:** 515 (Oct.) 1937.

In supposedly normal eyes removed at autopsy from patients over 50 years of age at the time of death, the authors found a thin layer of vascularized connective tissue situated between the pigment epithelium and the lamina vitrea and extending from the ora serrata to the equator. The origin of the vessels of this layer could not be determined. The layer itself is assumed to be derived from the subepithelial basal substance through a process of histolysis.

P. C KRONFELD.

Glaucoma

SOME UNUSUAL CASES OF GLAUCOMA SECONDARY TO INJURY. R. A. GREEVES, Brit. M. J. 2: 1107 (Dec. 4) 1937.

Greeves reports 4 cases of glaucoma following injury in which no mechanical explanation for the rise in tension was apparent.

CASE 1.—A man aged 21 was struck in the left eye by a football lace. Some time later he complained of attacks of pain, misty vision and haloes. The tension was found to be elevated during the attacks, and the eye was myopic. A solution of 0.25 per cent physostigmine salicylate controlled the attacks.

Two days after trephination examination showed papilledema of 6 diopters and numerous retinal hemorrhages, both of which disappeared within two months. The final vision was 6/4; the field was constricted nasally, and the peripheral retinal arteries were reduced in size. The tension has remained normal for ten years, although the trephine opening closed.

CASE 2.—A man aged 30 received a blow on the eye twenty-two years before the present examination. Fourteen years later he began to have attacks of pain and see haloes. At the present examination the disk was found deeply cupped, and there were an area of pigmentation below the macula and a large iridodialysis in the lower segment. The nasal field was contracted. No treatment had been instituted up to the time the case was reported.

CASE 3.—A man aged 50 had failing vision in the right eye for seven months. There was evidence of a perforating injury in the cornea, iris and lens. The tension was elevated, and the disk was cupped. A roentgenogram revealed an intra-ocular foreign body close to the ora serrata. After this was removed with the giant magnet, the tension fell to normal and was not affected by the administration of homatropine. There was no siderosis.

CASE 4.—A chauffeur had attacks of pain and misty vision in the left eye. He thought that a piece of china had entered the eye several months before. The tension was elevated, the disk was cupped and the vision was reduced to counting fingers at 1 meter. The anterior segment showed signs of a penetrating injury, and a roentgenogram revealed a foreign body in the vitreous. This proved to be nonmagnetic. Trephining successfully reduced the tension to normal.

Greeves thinks that the drainage channels were not altered in the first 2 cases. In the third case removal of the foreign body cured the glaucoma, while in the fourth case trephining kept the tension normal.

W. F. DUGGAN.

THE INFLUENCE OF MARCONITHERAPY (SHORT WAVE) ON PRIMARY GLAUCOMA. M. CORRADO, Ann. di ottal. e clin. ocul. 65: 401 (June) 1937.

Twenty patients with primary glaucoma were given treatments with the ultratherm, an apparatus employing a 6 meter wavelength, with setting of the voltmeter between 18 and 21. The Schliephake electrodes were used, the indifferent one (130 mm.) on the neck and the active

one (40 mm.) a few centimeters before the eye. The duration of the treatment was, as a rule, thirty minutes. The tension was recorded several times a day for a period before the treatment and every hour for from one to one and a half days after treatment. Miotics were not administered during the period of observation. The cases of primary glaucoma included both the simple and the inflammatory type, and a number of patients had been operated on by iridectomy or by sclerectoiridectomy.

In all cases relief from pain followed the treatment, regardless of whether the tension was reduced. The tension was markedly diminished in 7 of the 20 cases and moderately diminished in 6. It was not affected in the remainder. Among those patients who showed a marked reduction in tension was 1 with chronic glaucoma with an acute exacerbation (tension reduced from 39 to 19 mm.), 3 with chronic inflammatory glaucoma and 3 with simple glaucoma. One patient who was previously operated on with success showed a further reduction of tension after treatment. With relation to the number of patients treated, a marked reduction of tension occurred more often in those with chronic irritative glaucoma than in those with simple glaucoma and more often when tension was only moderately increased. The fall of tension began, as a rule, within from one to two hours after treatment and reached its maximum after from six to nine hours. The favorable effect on tension was secured either after the first treatment or in some cases after succeeding treatments. The tension returned gradually to the preceding level in all except 1 case, in which there was an acute exacerbation of chronic glaucoma. A temporary increase in vision, sometimes fairly marked, was seen in 8 cases, while the visual field showed an increase in only 2. The effect of treatment is attributed chiefly to the active vasodilation produced by the treatment, although other effects, such as an electrochemical change in the tissues, especially the vitreous, is also considered possible.

S. R. GIFFORD.

Lens

UNRECOGNIZED SYPHILIS IN ASSOCIATION WITH SENILE CATARACT. E. PUSCARIU, Ann. d'ocul. **174:** 596 (Sept.) 1937.

In 1927 Puscariu reported on the frequency of unapparent syphilis in cases of senile cataract. The article included the results of a study of 809 cases of cataract in which operation was performed.

Since that time there have appeared in different countries a number of articles on this question. In continuing this study, Puscariu found latent syphilis in 14.1 per cent of the cases of senile cataract. Late postoperative iritis appeared in 19 per cent of the cases in which the serum gave a positive reaction to the Bordet-Wassermann test. These represented 40 per cent of the total number of cases of postoperative iritis. Late iritis was rarely found in patients (3.74 per cent) whose serum gave a negative reaction to the test.

Puscariu reviews the different cases reported and emphasizes the likelihood of a parenchymatous keratitis appearing in syphilitic persons after trauma. A bibliography is included.

S. H. MCKEE.

Methods of Examination

STENOPEIC SPECTACLES. A. L. YOUNG, Brit. J. Ophth. **22:** 45 (Jan.) 1938.

In order to obtain a variable distance between the stenopeic openings in disks placed before the eyes, Young has devised a type of spectacles in which two disks back to back can be rotated independently of each other. Each disk is perforated by a curved slit, 2 mm. in width, the aperture being produced by the overlapping of the slits. By a suitable maneuver it is possible to place the aperture in any position on the disk save in the exact center, and this may be overcome by decentering an equal amount in each disk. Thus a vertical as well as a horizontal correction may be made.

A photograph of the spectacles accompanies the article.

W. ZENTMAYER.

Neurology

OCULAR SYMPTOMS IN CASES OF OLFACTORY MENINGIOMA. E. HARTMANN, M. DAVID and P. DESVIGNES, Ann. d'ocul. **174:** 505 (Aug.) 1937.

This article is based on the study of sixteen patients with meningioma of the olfactory groove in the service of Clovis Vincent, who were all examined and followed. In all the cases the diagnosis was verified by means of microscopic examination. In Vincent's service the cases of meningioma of the olfactory groove represented about 13 per cent of the total number of cases of meningioma. Ocular disturbances form one of the most important symptoms of meningioma of the olfactory groove. Their presence was noted in each of these sixteen cases. They may be divided into: (1) alterations in the fundus of the eye, such as bilateral papillary stasis (eight cases); primary bilateral atrophy of the optic nerve (three cases), and papillary stasis of one eye, with edema of the edges, associated with papillary discoloration of the other eye (two cases). The fundus was normal in one case. The syndrome of Foster Kennedy was not noted in any case, but in two cases a variation of this syndrome was observed.

Part II takes up visual acuity, which is subdivided into: decrease of visual acuity without ophthalmoscope lesions; visual acuity and papillary stasis, and visual acuity in the syndrome of Kennedy. Then is discussed in order, in part III, the visual field; in part IV, exophthalmos; in part V, the pupillary reaction; in part VI, the corneal sensibility, and in part VII, the motility of the globe.

The authors then take up the postoperative evolution of ocular symptoms. In discussing the diagnosis they state that the ocular symptoms just described may be observed in the course of other disorders, particularly in certain types of meningioma of the small wing of the sphenoid, tuberculous meningioma of the sella, tumor of the hypophysis, glioma of the chiasma and ventricular distention. A table giving the protocols of the sixteen patients is included.

S. H. MCKEE.

MALIGN TERATOID TUMOR IN THE HYPOPHYSEAL REGION. V. A. JENSEN, Acta ophth. **15:** 193, 1937.

In a 13 year old girl lack of appetite, emaciation, headache, drowsiness, vomiting, pareses of the ocular muscles and bitemporal hemianopia developed. In the course of a short time papillary stasis and involvement of other cranial nerves appeared. A roentgenogram revealed destruction of the sella turcica. The patient died after two and one-half months, and autopsy revealed a large interpeduncular tumor, with extension into one sphenoid sinus and both orbits. Histologic examination showed a teratoid tumor. There are two photographs showing the tumor grossly but no photomicrographs.

O. P. PERKINS.

Ocular Muscles

CONGENITAL ABSENCE OF ABDUCTION (CONGENITAL MUSCULAR STRABISMUS). C. V. LODBERG, Acta ophth. **15:** 247, 1937.

This article surveys the entire subject of congenital absence of abduction and cannot be well abstracted. Seven of the author's cases are briefly reported and the symptoms tabulated. The symptomatology is discussed in some detail, consideration being given to such topics as absence of abduction, limitation of adduction of the same eye, retraction of the globe, narrowing of the palpebral fissure, elevation of the globe on attempting adduction, protrusion of the globe and widening of the palpebral fissure on attempting adduction, difference in motility obtained by covering the fellow eye, head turning and vertical motility.

The pathologic anatomy underlying these functional disorders is discussed, reference being made to many of the various muscular anomalies recorded in the literature. There are brief sections devoted to etiology and treatment. This article, 50 pages long, in French, is well worth perusal by those interested in muscles. There is a bibliography of 90 references.

O. P. PERKINS.

Operations

ENUCLEATION WITH IMPLANTATION OF FOREIGN SUBSTANCES INTO TENON'S CAPSULE. C. BERENS, Am. J. Ophth. **20:** 293 (March) 1937.

Berens believes that suppuration following implantation operations performed after enucleation may be due to buried sutures or unsterile catgut. He therefore uses a silk suture for Tenon's capsule but goes through the conjunctiva first before catching the capsule and cut tendons. The conjunctiva is then sutured with interrupted sutures. The deep suture is removed on the fifth day after operation. Forty-five eyes have been operated on in this manner and only two gold balls were expelled.

W. S. REESE.

THE USE OF EVIPAL SODIUM IN OCULAR SURGERY. D. ARGÜELLO and R. F. PEREIRÀ, Arch. de oftal. de Buenos Aires 12: 178 (April) 1937.

In this paper the authors extol the advantages of evipal sodium when a general anesthetic is necessary.

After reference to its use in other branches of surgery, as reported in the literature, they explain its use by slow intravenous injection, commencing with 1 cc. of a 10 per cent solution in distilled water. The quantity required varies greatly, less being required in children than in adults. If sleep occurs after the first injection, a wait of from a minute to a minute and a half before operating is indicated. Schnitzler advises injection of an extra 0.5 cc. and a wait of from three to four minutes. There is some fall in the arterial tension and in the frequency of the pulse beat. The patient wakes up shortly after the operation and rarely complains of headache or dizziness. Waking can be hastened by the administration of caffeine or of coramines (a 25 per cent solution of pyridine beta-carbonic acid diethylamine). Vomiting is rare. Occasionally there is some after-excitement, which can be avoided by the prior use of chloral hydrate or of morphine. Evipal sodium has been employed in patients from 7 months to 86 years of age. Exceptionally there is a great resistance to the drug. Its use is contraindicated in persons with hepatic lesions, peritonitis and severe anemia and in persons in shock or coma. In aged persons it is necessary to adhere strictly to indicated doses and technic. If the patient wakes up before the operation is finished, an extra injection can be given or the anesthesia continued with ether or chloroform. The advantages in favor of its use are: the suppression of the stage of excitement, the inhalation of a disagreeable narcotic, the absence of postoperative vomiting and psychic shock, the rapidity of action, the absence of complaints and the avoidance of the use of a mask. Evipal sodium combined with local anesthesia is at times useful. The authors have not experienced any accidents.

C. E. FINLAY.

Orbit, Eyeball and Accessory Sinuses

SEX-LINKED MICROPHTHALMIA SOMETIMES ASSOCIATED WITH MENTAL DEFICIENCY. J. A. FRASER ROBERTS, Brit. M. J. 2: 1213 (Dec. 18) 1937.

Roberts discusses a family showing microphthalmia and presents a genealogic table covering 4 generations. In the 4 generations there were 14 persons with microphthalmia, all males. Six of these were examined by the author. Of these 6, 2 were of normal mentality, 1 was feeble-minded, 2 were imbeciles and 1 was an idiot. At least 3 of the 8 persons not seen by the author were mentally defective. There was no other mental deficiency in the family group apart from that associated with the blindness.

The eyes of the 6 patients seen by Roberts are described briefly. In general, they fall into the classification (by van Duyse) of microphthalmia without coloboma but associated with various abnormalities, such as corneal opacities, aniridia, smallness or absence of the

lens and opacities of the lens. In all 6 cases the eyes were sunken in the orbits, and the intra-ocular tension was minus. Five patients had nystagmus. Four corneas were smaller than normal. Eight corneas were partially or totally opaque. The iris was abnormal in 7 instances and the lens in 6 (in the other 6 eyes the lens could not be seen because of corneal opacities). In all 6 patients the abnormality was detected immediately after birth.

In his discussion Roberts notes that the appearance of the eyes varied considerably in different persons and that the two eyes in a single individual were often strikingly different. As examination was not made of the brain of any member of this group, it is impossible to say whether the mental deficiency, when present, was due to specific malformations or whether the entire brain would show the underdevelopment and maldevelopment characteristic of the brains of ordinary mental defectives.

In these cases the microphthalmia was inherited as a sex-linked recessive condition, and the mental deficiency, when present, occurred only in the microphthalmic members of the family.

W. F. DUGGAN.

Pharmacology

THE EFFECTS OF MYDRIATICS UPON INTRAOCULAR TENSION. H. S. GRADLE, Am. J. Ophth. **19:** 37 (Jan.) 1936.

In 500 consecutive patients past the age of 30 whose pupils had to be dilated for ocular examination Gradle made tonometric examinations immediately before the use of the mydriatic, two hours later and forty-eight hours later. He concludes that such measurements are highly advisable, as many cases of incipient glaucoma or preglaucomatous conditions may thus be found months or years earlier than they would be otherwise.

W. S. REESE.

Physiologic Optics

ANISEIKONIA. G. HARDY, Am. J. Ophth. **20:** 599 (June) 1937.

This article appears to be a dispassionate, scientific effort to determine the value of iseikonic lenses. The following summary is given:

"1. Some patients are benefited by the addition of a size lens to the dioptric correction. The percentage aided, however, has been less than that reported from other clinics.

"2. The size differences of a symptomless group of persons wearing corrections for errors of refraction were equal to the size differences of those seeking relief from asthenopia.

"3. Not infrequently the dioptric correction is altered at the time the iseikonic lens is prescribed. Obviously, when this occurs it is not possible to determine, with any assurance, which change is helpful.

"4. The muscle balance was not appreciably influenced by the iseikonic lenses.

"5. Vertical size determinations were made with greater ease than lateral ones, that is, the patient had less difficulty in making comparisons.

"6. The chief objection to the method employed is that it is tedious, tiresome, and difficult for the patient.

"7. Sufficient numbers of symptomless individuals should be examined in order to determine, if possible, what a normal size difference might be.

"8. Those prescribing iseikonic lenses should avoid incorporating other changes; that is, a change in the strength of the lens should be made before the size correction is prescribed and not at the same time. Otherwise accurate deductions are impossible."

W. S. REESE.

Physiology

THE INTRA-OCULAR FUSION MECHANISM. G. SCHUBERT, Arch. f. Ophth. **137:** 506 (Oct.) 1937.

With Gullstrand's method of stigmatoscopy, Schubert demonstrated on himself and on other persons with normal binocular vision that on changing from uniocular (one eye covered) to binocular, symmetrical or asymmetrical convergence, a change in the dynamic refraction occurred in the eye that had been covered, in addition to the ocular movement for the correction of the slight amount of heterophoria. This change in refraction was consistent and characteristic of the conditions of the particular experiment. Schubert interprets these phenomena as changes in the degree of accommodative effort, changes which are made in the interest of fusion and which suggest the possibility of unequal accommodation in the two eyes. Thus, there is an intra-ocular fusion mechanism.

P. C. KRONFELD.

THE DIALYSATION OF THE INTRA-OCULAR FLUIDS. STEWART DUKE-ELDER, Brit. J. Ophth. **21:** 577 (Nov.) 1937.

The author discusses the point raised by Robertson in a recent article (*Brit. J. Ophth.* **21:** 401 [Sept.] 1937) and in his summary gives the following conclusions:

"In summary it may be stated that the aqueous humor is not a simple dialysate as I originally hypothesized. On the other hand there is no positive evidence for the theory that it is a secretion of the ciliary epithelium. An hypothesis which I had already adumbrated eighteen months ago is advanced, admittedly on experimental evidence which is yet insufficient for its full development, that, having dialysed from the intra-ocular capillaries and before reaching the chambers of the eye, the fluid passes through a physiological membrane the properties of which maintain a concentration gradient to some molecules, a degree of unidirectional permeability to other molecules, alterations in the properties of which may account for many obscure but important pathological phenomena. As our knowledge stands at the moment I can see little value in further arguments which must be based on insufficient premises: the sensible course is to continue in the search for further and more accurate experimental facts."

W. ZENTMAYER.

Refraction and Accommodation

REFRACTION ERRORS IN THE SAME EYES UNDER SCOPOLAMINE AND UNDER ATROPINE CYCLOPLEGIA. L. BOTHMAN, Am. J. Ophth. **20:** 822 (Aug.) 1937.

Refraction was performed on 400 eyes under 0.5 per cent scopolamine hydrobromide and under 1 per cent atropine sulfate, and the results were compared. The following conclusions were arrived at:

"Scopolamine is not so complete a cycloplegic as atropine.

"The findings under scopolamine closely approximated those for atropine. In 18 per cent of the examined eyes there was no change. The difference in hyperopia was 0.37 D. less and in myopia 0.37 D. more than under atropine. The average difference in 400 eyes was 0.33 D. The difference between findings in patients over 40 years of age was almost negligible.

"Scopolamine is not a trustworthy cycloplegic when used for patients with good unaided vision if weak myopic or mixed-astigmatism errors are found, nor in patients under 16 years of age. Such patients should be refracted under atropine."

W. S. REESE.

Retina and Optic Nerve

COMPLETE RETINAL DETACHMENT (BOTH EYES). R. M. BALYEAT, Am. J. Ophth. **20:** 580 (June) 1937.

Balyeat reports the case of a 21 year old woman in whom eczema developed at the age of 3 months and asthma and hay fever at the age of 1 year. At the age of 17 a retinal detachment appeared in one eye and then in the other. A roentgenogram revealed calcified deposits in each eye which appeared to be in the retina but were more likely in the vitreous or in the lens. The lenses were opaque. Balyeat discusses the possibility of the detachments' being due to allergy, since the retina is of ectodermal origin and because of the allergic disturbances in the skin, which is also of ectodermal origin.

W. S. REESE.

DEFECTIVE CENTRAL VISION FOLLOWING SUCCESSFUL OPERATIONS FOR DETACHMENT OF THE RETINA. A. B. REESE, Am. J. Ophth. **20:** 591 (June) 1937.

From a review of cases of retinal detachment in which operation was performed, Reese found that approximately normal vision (20/30) was obtained in only about one third of cases in which the operation was successful. He studied cases of detachment in the early stage in which there were no complicating features, in all of which there were cysts in the macula; indeed, they seemed to appear in the macula first and to there attain their largest size. The following conclusions were drawn:

"1. A cystic degeneration of the macula accounts for the poor central vision after the reattachment of a detached retina that involved the macular region.

"2. The defective central vision so frequently found following successful operations for detachment of the retina suggests that a macular detachment with cyst formation was present even though it might not have been recognized clinically."

W. S. REESE.

RARE FORMS OF TAPETORETINAL DEGENERATION: REPORT OF CASES. K. LISCH, Klin. Monatsbl. f. Augenh. **98:** 498 (April) 1937.

Lisch observed an unusual form of tapetoretinal degeneration in 4 boys of a family of 6 children. One boy aged 13 and a girl aged 17 had healthy eyes.

Consanguinity of the parents did not exist, and ocular disorders in other members of the family were unknown, except in a sister of the children's father; she could not see well with one eye and had a cataract extracted. The ages of the 4 boys were 20, 19, 16 and 15, respectively. The vision was reduced in each of them, but it did not deteriorate allegedly except in the boy aged 19, who had bilateral holes in the macula. The peripheral field of vision was not considerably narrowed in any of them, and in two it was normal. Two boys had defects in the nasal and upper portions of the field, coupled with central scotomas and with reduced dark adaptation.

The changes in the maculas of these 4 boys consisted of irregular pigmentation and radial streaks, which may represent folds in the internal limiting membrane, produced by edema. The degenerative changes consisted of grayish white retinal foci of varying form and size and of fine irregular accumulations of pigment. Three boys had atrophy of the optic disks, which were not well outlined. The central retinal vessels showed invagination resembling perivasculitis. This symptom was considered indicative of marked pathologic involvement of the vascular system of the retina. The boys were intellectually normal, with the exception of the boy aged 19, who had choreatic restlessness and was physically underdeveloped.

K. L. STOLL.

HISTOLOGIC STUDY IN A CASE OF COMPARATIVELY RECENT SPONTANEOUS DETACHMENT OF THE RETINA IN AN AGED MYOPIC PATIENT. A. VOGT, Klin. Monatsbl. f. Augenh. **98:** 735 (June) 1937.

Vogt adds another case to the small list of cases of spontaneous detachment of the retina of from one day's to a few weeks' standing. The left myopic eye of a woman aged 72 was removed two years prior to observation. In front of the right eye, which showed myopia of 11 D., a shadow suddenly appeared, and detachment of the retina was found on the following day. Two days later preliminary katolysis was performed; the retina was partly reattached after three weeks, but the hole in the retina was still open. The patient's general physical condition rendered a second operation impossible. She died from peritonitis following an operation for inflammatory ectasia of the gallbladder thirty-seven days after the detachment was discovered. The eyeball was enucleated thirty minutes after death and hardened in a solution of formaldehyde. A detailed description of the histologic examination is given, with 14 photomicrographs, some of them colored.

The findings furnished evidence that the detachment could not have been caused by traction in the sense of Leber's and of Gonin's theories, because inflammatory changes in the vitreous were totally absent. Vogt reasons that degeneration of the retina is preexisting and that this degeneration causes the formation of the hole. Degeneration and slinging of

the vitreous are secondary symptoms. Some of the sections show cystic decay and marked thinning and atrophy of the retina near the hole. The ocular motion causes the slinging called "Jactatio corporis vitrei" by Vogt in his book; it exerts a pull on the fibers of the vitreous where they are attached to the thinned portion of the retina, so that the "lid" is torn off. Adhesions between the posterior portion of the vitreous and the internal limiting membrane occur in normal eyes. Salzmann called these solid adhesions in the periphery of the vitreous the "basis of the vitreous." The myopia of this patient cannot have caused the retinal tear by traction or overstretching.

K. L. STOLL.

LATENT HOLES IN THE RETINA WITHIN THE AREA OF A COLOBOMA OF THE CHOROID AND TRAUMATIC DETACHMENT OF THE RETINA: REPORT OF A CASE. R. TERTSCH, Klin. Monatsbl. f. Augenh. **98:** 751 (June) 1937.

Tertsch records 5 cases of coloboma of the choroid in the area of which traumatic detachment of the retina developed. He adds his own observation on a woman aged 30 whose right eye was struck by a piece of wood. The retina became detached over a congenital coloboma of the choroid, one of which existed also in the left eye. The retina in these areas in each eye consisted of a thin yellowish membrane, which showed several perforations; they were considered to be congenital, but latent. The injury produced a genuine detachment of the retina in this predisposed eye.

K. L. STOLL.

Trachoma

SPECIFIC TREATMENT OF TRACHOMA. V. DERKAČ, Arch. f. Ophth. **138:** 270 (Dec.) 1937.

Derkač transplanted pieces of trachomatous tissue (containing conjunctiva and follicles) directly from the eye of each of a group of young patients suffering from follicular nonsecreting trachoma into subcutaneous pockets on the forearm of the same patient. This procedure was repeated several times and seemed to have a definite beneficial influence on the course of the trachoma. In the majority of the patients treated with this method the trachoma became rapidly regressive and subsided after a few months. The author believes that patients so treated become more resistant against reinfection.

P. C. KRONFELD.

BRILLIANT GREEN IN THE TREATMENT OF TRACHOMA. T. K. KRYLOV and B. I. ROSTOVTZEV, Sovet.-vestnik oftal. **9:** 902, 1936.

Twenty patients with recent trachoma without involvement of the cornea were treated with (1) instillations of a 1:200 and 1:500 aqueous solution of brilliant green (tetra-ethyl-diamino-triphenylmethane sulfate) twice daily and (2) subconjunctival injections from 0.1 to 0.5 cc. of a 1:1,000 and 1:4,000 solution of brilliant green in from three to six days. In a few cases one eye was treated with a copper sulfate pencil for a comparison of the results. The subconjunctival injections and the drops

were painful and caused a marked reaction. However, the instillation of drops usually stopped the excessive purulent discharge in one or two days.

The authors conclude that brilliant green does not improve the course of the trachomatous process and therefore has no value in the treatment of trachoma and that preference can be given to the old method of treatment with a copper sulfate pencil.

O. SITCHEVSKA.

Tumors

INTRASCLERAL EPITHELIAL CYST. M. SALZMANN, Ztschr. f. Augenh. **92**: 275 (Aug.) 1937.

Five cases of this rather unusual condition are reported, with detailed histologic studies in 3. One cyst was successfully removed by simply dissecting away the outer wall, the epithelium of the inner wall being allowed to take the place of the normal conjunctiva. In all the cases the cysts followed perforating injury to the region of the limbus corneae by blunt instruments and were associated with prolapse of the iris and gapping wounds during healing. Four of the 5 cases occurred in children from 4 to 12 years of age. The cysts appeared some years after the original injury, and growth was accelerated later in the course of the disease. The shape of such a cyst is characteristically bean-shaped or kidney-shaped, or even sausage-shaped, with the largest circumference away from the limbus.

The largest tumor in Salzmann's cases extended as far back as the insertion of the inferior rectus muscle, but others have reported cysts in shrunken globes which have extended as far back as the optic nerve. There was no invasion of the cornea in this case, except where it was badly damaged by the original injury.

The cysts were scleral-white and covered with normal movable conjunctiva. The former factor alone differentiates this type of cyst from scleral ectasia and intercalary staphyloma. The edges of the cysts were sharply demarcated from the normal sclera. The cysts were translucent and had no pigment spots or streaks. Histologically, they were found to be lined with several layers of pavement epithelium. The basal layer was more similar to corneal than to conjunctival epithelium. Salzmann feels that this layer originates from the cells in the region of the limbus, which proliferates as it would in healing over a flat surface. The bulk of the walls of these cysts was made up of normal scleral connective tissue, as if the cysts had merely dissected in between the layers of the sclera. The occurrence in children and the limitation of the cysts to the anterior sclera where the lamination was more definite would uphold this idea. The cysts were filled with a clear fluid, which was felt to be a secretion product of the epithelium and not aqueous. In 2 of the cases part of the cyst was intra-ocular. In 1 case the cyst invaded the posterior chamber, and there was a free communication with the intrascleral cyst. In the other case the cyst occurred in the anterior chamber, but no direct communication was found with the intrascleral cyst. The relation to epithelial cysts in the anterior chamber is obvious and is discussed at length. Drawings and photomicrographs illustrate the article.

H. GIFFORD JR.

TRAUMATIC CYST OF THE IRIS: REPORT OF A CASE. A. LUNDBERG, Acta ophth. **15:** 204, 1937.

This article deals with the formation of a cyst in the anterior chamber of an eye injured in an explosion five and one-half years before removal. The cyst appeared two and one-half years after the injury and is ascribed to the proliferation of conjunctival epithelium driven into the eye by a minute foreign body. Three years later, because of secondary glaucoma, the eye was trephined and the cyst punctured. No benefit resulted. Electrolytic treatment of the cyst was also unsuccessful. One of these operative procedures probably lacerated the iris proper and so contributed to the formation of another cyst entirely within the substance of the iris. Three photomicrographs accompany the article.

O. P. PERKINS.

SARCOID OF BOECK: REPORT OF A CASE. E. HOLM, Acta ophth. **15:** 235, 1937.

A man of 63 presented a thickening of the tissues beneath one lower conjunctival fornix. Below the outer canthus, a firm tumor the size of a bean was palpable. This was readily removed, though it was connected with the linear thickening along the lower orbital margin. There were no cutaneous lesions.

Microscopically, the tissue consisted of nodules of large epithelial cells in a connective tissue matrix. Isolated giant cells were found. There was no necrosis. Masses of lymphocytes surrounded the nodules. A diagnosis of Boeck's sarcoid was made.

Some sclerosis of the hilus glands and a strongly positive Pirquet reaction tended to support the theory which holds tuberculosis to be the causal agent.

O. P. PERKINS.

RING SARCOMA OF THE IRIS AND CILIARY BODY: REPORT OF A CASE. VON OVE BOJE, Acta ophth. **15:** 239, 1937.

The case reported is notable first for the age of the patient, a 6 month old boy, and second for the extreme rapidity of the growth of the tumor, only three weeks having elapsed between the first appearance of a small brownish yellow spot on the iris and the extension of this pigmented area over the entire iris. The diagnosis made prior to enucleation was confirmed by microscopic examination.

O. P. PERKINS.

Uvea

UVEITIS: THE ROLE OF INTRAOCULAR TYPHOID-ANTIBODY CONTENT IN TREATMENT. A. L. BROWN, Am. J. Ophth. **20:**583 (June) 1937.

Brown discusses the treatment of uveitis and reports 5 cases in which he used typhoid H antigen intravenously followed by aspiration of the anterior chamber. He summarizes the results in a group of cases in which this type of treatment was used. They were gratifying, and no untoward reactions or accidents were experienced.

W. S. REESE.

THE VALUE OF DIAGNOSTIC ROENTGEN EXAMINATION OF THE SPINE IN CASES OF IRITIS: REPORT OF CASES. H. SCHLEY, Klin. Monatsbl. f. Augenh. **98:** 780 (June) 1937.

To stress the difficulty encountered in establishing the correct cause of planar iritis, Schley refers to Gilbert's report on 500 cases, in over 17 per cent of which the origin remained unknown. Roentgen examination of bones and joints, especially of the small bones of the spinal column, has recently become valuable in arriving at the cause of the lesion. The most frequent conditions revealed in the roentgenograms are spondylarthritis ankylopoietica and spondylosis deformans. Schley compiled reports of 105 cases of iritis, 32 of which were of the localized type and 73 of which were of the superficial type. Four cases are reported in detail. The patients were observed at the University Eye Clinic of R. Thiel in Frankfort on the Main. The results of the examinations of the spine were as follows: 1. Patients with tuberculous and syphilitic iritis showed absolutely no changes in the spine. 2. In 73 patients the superficial iritis had a clear rheumatic causation, the diagnosis being based on the results of the clinical examinations and the therapeutic effects of salicylic acid and other antirheumatic agents. Of these 73 patients, 10 had spondylitis ankylopoietica, 40 had spondylosis deformans, while 23 showed no changes in the spine.

According to Junghanns' statistics, spondylosis deformans is equally frequent in both sexes; after the fifth decade of life almost 80 per cent of all men and over 60 per cent of all women suffer from it; after the seventh decade more than 90 per cent of all human beings are afflicted with it. Schley is not of the opinion that rheumatic iritis is caused by spondylosis deformans, except in some rare cases cited. He considers this disease of the spine as the result of wear and tear during life and the iritis associated as an incidental condition. Schley found no support for Krebs' opinion that spondylosis deformans may develop on an inflammatory base if the sedimentation time of the blood is increased. The diagnosis of true rheumatic iritis may be difficult, but the condition is associated with spondylitis ankylopoietica in only a small number of cases.

K. L. STOLL.

Sympathetic Ophthalmia

THE RHINOGENIC ORIGIN OF SYMPATHETIC OPHTHALMIA. B. WALDMANN, Am. J. Ophth. **20:** 618 (June) 1937.

After improvement in several cases of serous iritis in which nasal treatment was employed, Waldmann comes to the following conclusions:

"Spontaneous serous iritis and sympathetic ophthalmia are identical affections. Both are seasonal ailments, and the common causative agents are lodged in the nose.

"Injury, operation, likewise tuberculosis and syphilis only serve to prepare in the uvea a site of lowered resistance."

W. S. REESE.

Therapeutics

ADRENALIN CHLORIDE 1:100 IN OPHTHALMOLOGY. O. BARKAN and S. MAISLER, Am. J. Ophth. **20:** 504 (May) 1937.

Barkan and Maisler have found the instillation of drops of a 1:100 dilution of epinephrine hydrochloride into the conjunctival sac a very satisfactory substitute for subconjunctival injections of synthetic preparations of epinephrine. This dilution of epinephrine is very stable, and its administration by this method does not require anesthetization. It does not seem to cause systemic or local reactions. The authors refer particularly to the use of epinephrine hydrochloride in the treatment of glaucoma secondary to uveitis.

W. S. REESE.

AUTOHEMOTHERAPY IN PARALYSIS OF OCULAR MUSCLES. R. CAMPOS, Riforma med. **53:** 1439 (Oct. 9) 1937.

Campos reports satisfactory results from autohemotherapy in 2 cases of paralysis of the ocular muscles following hemiplegia of nuclear origin. The technic is as follows: Twenty cubic centimeters of blood is taken from a vein of the patient's arm and immediately reinjected at the gluteal region, which is then massaged for some time. The injections are made at intervals of two days alternately on each side of the gluteal region until ten injections are given. The condition of the author's patients was slowly but progressively aggravated during the first month before he resorted to autohemotherapy. The latter induced in both cases complete regression of the symptoms and functional reestablishment in about one month. The treatment is simple and harmless.

J.A.M.A. (W. ZENTMAYER).

SHORT WAVE THERAPY IN OPHTHALMOLOGY. J. KRAUSE, Ztschr. f. Augenh. **89:** 266 (July) 1936.

A review of the literature from 1935 indicated that short wave therapy had been applied to ocular conditions of various types with varying degrees of success. Favorable results were obtained in cases of herpes simplex, herpes zoster, interstitial keratitis and serpent ulcer. Rabbits with herpes simplex improved for one or two days, and then the lesions continued to spread.

The treatment of abscesses of the lid and orbit and acute dacryocystitis was reported by Sattler to give exceptionally good results. Twelve patients with iritis were also improved with short wave therapy. Wegener reported a case in which retinal hemorrhage occurred while treating a patient with a tuberculous process.

The experimental work of Krause showed that treatment of normal rabbits on ten consecutive days for periods of a half hour produced only slight hyperemia of the globe. None of the changes reported by Grüter were seen. He observed rather rapid healing of experimentally produced staphylococcic ulcers in animals when a wavelength of 4 meters was used. In a second series in which a wavelength of 6 meters was used the results were indefinite.

Experiments on pigs' eyes showed that the temperature of the globe was raised equally well by having the electrodes slightly out

of line as by having them exactly opposite each other. Similar results were observed on an eye embedded in fat in a human skull with one electrode on the temple and one slightly to the nasal side of the globe. In this position there is no heating effect produced in the brain which might possibly be a disadvantage. Slightly larger electrodes gave slightly higher temperatures. The larger electrode measured 4 cm. in diameter. The glass around it measured 5 cm., and the distance of the electrode from the front of the glass was 3 cm. The smaller similar electrodes measured 1.8, 2.5 and 1.5 cm. The distance from the skin is regulated by its tolerance for heat but should not be made too small.

In general, Krause's clinical results were similar to those published in previous reports. Hordeoleum, abscesses of the lid and dacryocystitis responded surprisingly well. In 1 case of panophthalmitis prompt healing occurred. In 1 case of sympathetic ophthalmia no improvement had occurred with five treatments, and eight days after the last treatment there was hemorrhage in the anterior chamber. In 1 case of herpes and 2 of disciform keratitis no special results were noted. Krause believes that many more conditions should be treated with the short waves before the clinical value of this form of therapy for diseases of the eye can be determined. The healing action of the short waves was limited to the ability to increase the temperature of the tissue and the resulting hyperemia.

H. GIFFORD JR.

Society Transactions

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L. W. DEAN, M.D., St. Louis, *President*

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SCIENTIFIC SESSION: OPHTHALMOLOGY

CHLOROMA: REPORT OF A CASE. DR. A. D. FROST, Columbus, O.

A boy aged 4 years was first examined by me because of swelling of the left upper lid of two months' duration. He felt perfectly well and had no other complaints. Physical examination revealed a well nourished boy, of normal development. Except for a few palpable posterior cervical and axillary lymph nodes, exophthalmos and downward displacement of the left eye were the only abnormal findings. The exophthalmos was caused by a circumscribed, somewhat nodular, hard tumor mass, which was slightly visible between the globe and the lateral portion of the roof of the orbit. Examination did not reveal any edema of the conjunctiva, lagophthalmos, loss of motility or diplopia. The vision was normal so far as could be determined by illiterate tests, and the fundi were normal. A roentgenogram of the skull and orbit did not reveal any osseous changes or destruction. Two weeks later there was a noticeable enlargement of the tumor of the left orbit, and in addition another tumor had appeared in the same position in the right orbit. The blood count at this time showed 32,000 white cells, with approximately 82 per cent myelocytes. The tumor was removed from the left orbit; it measured 3 by 3 by 1 cm. Gross examination of the tumor and the frozen sections established the diagnosis of chloroma.

After the patient made a satisfactory convalescence, a total of 2,400 roentgens was administered in eight applications. About six weeks later the tumor of the right orbit was removed and was found to be pathologically identical with that removed earlier from the left orbit. The patient's condition improved for a time, but three weeks after the last operation he failed rapidly. There were pain in the abdomen and abdominal distention, followed by involuntary defecation and urination, rectal prolapse and bleeding. The temperature rose to 104 F., and the breathing became labored; death followed.

Pathologic study revealed that the soft tissues about the right eye were ecchymotic, swollen, ulcerated and injected. The mesenteric lymph glands were slightly enlarged; the sternum showed a slight bluish nodularity on the left side; the spleen weighed 110 Gm., and the peripancreatic lymph nodes were markedly enlarged. There were many greenish nodules along the vertebrae and ribs. The peculiar dirty grayish

green character of the tumor, its predilection for periosteum and the established myelogenous leukemia placed it in the class of tumors called chloroma.

DISCUSSION

DR. T. L. TERRY, Boston: The great difference between chloroma and myelogenous leukemia is that the former is characterized by the development of a green tumor. The significance of the tumor may not be known until the cause of the green color is fully understood. There have been many attempts to explain the color, as Dr. Frost has pointed out. Thomas and Bigwood (*Compt. rend. Soc. de biol.* **118:** 381, 1935) expressed the belief that it is due to porphyrin, since they have shown the presence of free porphyrin in the tumor by spectroscopic study and have recovered porphyrin from the tumor by extraction with glacial acetic acid and ether.

Why do these green tumors have a predilection for growth in orbital tissue? The orbit is remarkably free from lymph nodules. It must certainly have lymphatic channels which have little or no connection with the lymphatic channels of the face and neck. It is possible then that the very lack of free communication of lymph channels to the face and neck may tend to produce a physiologic lymph stasis in the orbit. Such a condition would favor development of myelogenous, chloromatous or lymphomatous nodules.

The appearance of white centers in retinal hemorrhages is presumably diagnostic of leukemia, although this change is not invariably present. The white area is due to an accumulation of abnormal white blood cells in the center of the hemorrhage. I should like to ask Dr. Frost if this change is also observed at times in cases of chloroma.

DR. GEORGIANA DVORAK-THEOBALD, Chicago: Chloroma is a rapidly growing malignant neoplasm, involving the hemopoietic system, with metastases of cells to distant organs, and associated with a leukemic blood picture. It is almost invariably fatal, with a duration of from three to five months after recognition.

Up to the present, about 200 cases have been reported in the literature.

The most characteristic sign is the predilection of such tumors for the periosteum of the cranial bones, especially of the orbit.

The rapidity of growth and the extent of the orbital tumor may give rise to a number of ocular symptoms, namely, exophthalmos, drying of the cornea (due to extreme proptosis), optic neuritis, retinitis, sluggish reactions of the pupils, anisocoria, mydriasis, conjunctivitis, cataract, exotropia and nystagmus. In one type of chloroma the aural structures are affected.

The tumor apparently arises from a localized growth of leukemic deposits or metastases, and the tumor cells metastasize in the blood to produce leukemia.

In about half of the cases the periosteum of the orbital bones is the site of predilection. Why this is so is not known.

Differentiation between chloroma and myeloma is based on the usual blood picture of leukemia and the green tumor in cases of chloroma and on the tendency to spontaneous fracture in cases of myeloma. The Bence Jones type of protein is usually present in the urine of patients with myeloma and is only rarely present in that of patients with chloroma.

It is thought that the green color of chloroma is due to a lipochrome or to a blood pigment, but nothing is definitely known. According to Roehn and his associates, it is due to phagocytosis of the blood by endothelial cells in obstructed capillaries.

DR. A. D. FROST, Columbus, O.: I did not observe any retinal hemorrhages in this case, nor did I find any discussion of this subject in the literature. In most cases of myeloid leukemia, I understand, there are no characteristic retinal hemorrhages, but they are prevalent in cases of lymphatic leukemia. A probable explanation may lie in the fact that in the lymphatic type of leukemia there is more definite thrombopenia than there is in the myeloid type.

I might add that the autopsy did include a rather thorough examination of this boy's one eye, and I have never had a better section of a normal eye throughout.

EPITHELIAL INVASION OF THE ANTERIOR CHAMBER OF THE EYE FOLLOWING OPERATION AND INJURY. DR. C. A. PERERA, New York.

A survey of the literature reveals that epithelial invasion of the interior of the eyeball produces three different types of lesions: (1) "pearl" tumor of the iris, (2) post-traumatic cyst of the iris and (3) epithelization of the anterior chamber. In a patient with lifelong myopia of high degree a cataract developed; it was removed within the capsule after preliminary iridectomy. Extraction was followed by incarceration of the temporal pillar of the iris in the operative wound, mild uveitis and prolapse of the vitreous into the anterior chamber. Vision with correction was later improved to 20/30. More than fourteen months later the eye became congested and a cyst was found lying between the temporal pillar of the iris and the posterior surface of the cornea. The right eye was treated with five doses of 150 roentgens at weekly intervals until a total of 750 roentgens had been given, a 200 kilovolt peak, a filter of 0.5 mm. of copper and a skin-target distance of 50 cm. being used. When the patient was examined in June 1935, the cyst had shrunk to a light yellowish mass. In August 1935 a slight reformation of the cyst had taken place, and a second series of five treatments was given, a 108 kilovolt peak, a filter of 3 mm. of aluminum and a skin-target distance of 25 cm. being used. The patient's right eye received a total of 1,550 roentgens in the two series of treatment. By the middle of October 1935 the cyst had disappeared. When the patient was examined in August 1937, there was still no evidence of a cyst in the anterior chamber of the right eye.

A flap of superficial corneal tissue was introduced experimentally into the anterior chambers of rabbits. The corneal epithelium, which proliferated rapidly immediately after the operation, gradually became degenerated and disappeared. The entire implanted flap became absorbed within three weeks, with the formation of an anterior adhesion of the iris in all rabbits. Epithelization of the anterior chambers of normal rabbits could not be produced by this method.

DISCUSSION

DR. F. BRUCE FRALICK, Ann Arbor, Mich.: This condition has been observed but twice in the past decade in the ophthalmologic clinic

of the University of Michigan. It followed a perforating injury in each instance. In 1 case the epithelial invasion was through the center of the cornea, resulting in an epithelial cyst of the anterior chamber, and in the other case an hourglass epithelial cyst developed, lining the anterior and posterior chambers, and communicated through the limbus with a large subconjunctival epithelium-lined cyst. In the latter case the conjunctiva was apparently injured, and in addition there was a subconjunctival perforation at the limbus into the anterior chamber. Both eyes were glaucomatous when seen. In both instances serial sections revealed evidence of iris tissue incarcerated in the perforation, as found in Dr. Perera's case.

It is encouraging to hear of another favorable therapeutic result by the use of roentgen irradiation, since most conscientious roentgenologists will not admit of a selective affinity of the roentgen rays for normal surface epithelium. If no such selective action on the part of the roentgen rays exists, the question must be asked as to how they could destroy surface epithelium growing in the anterior chamber and yet not destroy the same epithelium on the anterior corneal surface, where it is closer to the source of radiation and thus receives a more intense dose. It might be that the epithelium in the anterior chamber is growing under such unfavorable circumstances that it is vulnerable to a dose of roentgen rays which would have no harmful effects on the same tissue when growing in its normal environment.

Dr. Perera used high voltage roentgen radiation, which is considered as "deep therapy." In the treatment of epithelial cyst of the anterior chamber one is concerned not with deep penetration but rather with the superficial therapeutic effects; so the filtration and kilovolt peak used could be considerably decreased and yet give the same ionization in the anterior chamber of the eye. This suggestion is offered not as a criticism of Dr. Perera's technic, since a brilliant result was obtained, but merely to point out that the same ionization or destruction of the epithelial cells in the anterior chamber should be obtained without the use of roentgen rays which have such depth of penetration. If a low penetrating beam of roentgen rays generated at low voltages was used instead of high voltage, or "deep," therapy, it might be an important factor in preventing the formation of cataract or vascular degeneration in the retina or in the choroid.

Dr. W. E. Fray, Philadelphia: I think that Dr. Perera has developed an interesting experimental method to study this condition. Although his results are essentially negative, I believe that they are nevertheless important.

One obvious conclusion which may be drawn from this is that corneal epithelium implanted in the eye of a healthy rabbit is rapidly absorbed and destroyed, and in order to obtain growth and continued proliferation of epithelium into the anterior chamber some other factor is necessary, such as trauma, inflammation or some degenerative condition.

In slides illustrating this condition, of which I have been able to examine a number which are in the collection of the Wills Hospital, there is either absence of or marked degenerative change in the corneal endothelium. In one such slide the endothelium is absent even at places where epithelial tissue does not cover the posterior corneal surface.

Previous experimenters have reported fistulization and continued hypotonia as important predisposing causes of the proliferation of epithelium. It does not seem to me that the continued hypotonia is a primary cause; it seems, rather, that the continued hypotonia is responsible for other damage in the eye which permits epithelium to continue to grow.

REFRACTIVE ERRORS IN THE SAME EYES WHILE UNDER THE INFLUENCE OF HOMATROPINE, SCOPOLAMINE AND ATROPINE. DR. LOUIS BOTHMAN, Chicago.

This is a report on the analysis of changes in refraction in 200 eyes (100 persons under 40 years of age) while under the influence of the drugs most commonly used in retinoscopy—homatropine hydrobromide, scopolamine hydrobromide and atropine sulfate.

All of the eyes were examined by retinoscopy at a distance of 1 meter, a concave mirror being used.

Homatropine hydrobromide in a 2 per cent aqueous solution was instilled into the conjunctival sacs. Six drops were used at intervals of ten minutes, and the retinoscopic examination was made ten minutes after the final drop was given.

Scopolamine hydrobromide was used in 0.5 per cent aqueous solution. Two drops were used at intervals of a half-hour, and the test was made fifteen minutes after the second drop was instilled.

Atropine sulfate in a 1 per cent aqueous solution was used by the patient before retiring the first night and four times daily for three days and in the morning of the day of the examination. In all, 14 drops were used. Scopolamine is a more complete cycloplegic than homatropine, while atropine gives more complete cycloplegia than either of the other two drugs.

DISCUSSION

DR. ROBERT J. MASTERS, Indianapolis: Ophthalmologists agree that the use of a cycloplegic is absolutely essential to the accurate measurement of the refraction of the eyes of persons under 45 years of age. Homatropine should not be used in a concentration as weak as the 2 per cent solution of the hydrobromide. When used in this strength it has seldom been an effective cycloplegic in my experience. For satisfactory results a 4 per cent solution should be employed, with or without the addition of cocaine hydrobromide to make a 2 per cent solution of the latter. Five instillations at intervals of from ten to fifteen minutes, with retinoscopic examination begun from seventy to eighty minutes after the first instillation, have given cycloplegia that has been consistently satisfactory during seven years of experience. The drops are always instilled by my brother or myself. I have mentioned this only to drive the point home that it is better for the physician to instill the drops himself than to have an office assistant do it, and every one knows that it is more satisfactory to do it oneself than to have the drops instilled in the home.

DR. JOHN F. GIPNER, Rochester, N. Y.: Dr. Bothman is obviously in favor of atropine sulfate, since he uses 14 drops of a 1 per cent solution within three and a half days and only the generally accepted minimal doses for the weaker drugs. As one who has found homatro-

pine usually satisfactory, I wish that he had made, or would in the future make, a better case for the two weaker cycloplegics, giving them an opportunity to establish as complete cycloplegia as possible by varying the dose or strength of the solutions as is found necessary.

Certainly the almost universal use of the weaker cycloplegics reflects the demand of the public for the least prolonged disability to the accommodation which is commensurate with reasonable accuracy in measuring refractive errors.

Whether or not one will use atropine in routine refraction will largely depend on one's philosophy of the art and science of refraction.

If one proceeds on the concept that the full correction of the refractive errors as found with complete cycloplegia is necessary for the comfort of the patient and that one can only consider a scientific reduction of the patient's refractive error to the emmetropic state with glasses, then one will use atropine sulfate alone in examining all patients for refraction.

However, if one proceeds on the basis of another philosophy of the art and science of refraction and chooses to be less the scientist but more the artist in examining patients, and if one respects hypertrophy of the ciliary muscle as physiologic and worthy of keeping as long as symptoms of accommodative strain are controlled, one will give more consideration to the control of accommodation in refraction with milder cycloplegics and will also master the art of manifest refraction.

Dr. Oscar Wilkinson, Washington, D. C.: About twenty years ago I studied a series of 50 patients with refractive defects, employing homatropine and atropine as cycloplegics. I concluded that with the atropine there was a greater amount of refractive defect in a considerable number of the patients, but this defect was usually under 0.5 diopter. I found the amount of astigmatism and the axis of astigmatism to vary little. I believe that the eyes of all subjects under 14 or 16 years of age should be atropinized, as the difference in the refractive defects obtained with the two drugs was greater in the younger patients. The history of the patient may have a great deal to do in determining which drug one should use. In other words, I believe that if a patient even over 20 years of age has not been satisfactorily fitted with glasses, or at least is still having trouble with his eyes after numerous examinations, atropine should be employed.

As to the use of homatropine, I find that if it is used the night before examination and again in the morning, as was recommended by Dr. Bothman, and in addition an occasional drop of a weak solution of cocaine hydrochloride is used, the cycloplegia will be satisfactory.

With reference to scopolamine and its toxic effect, I have found that young subjects who come to the office with empty stomachs are more susceptible to intoxication from this drug than those who come in after having eaten. It is now my custom, particularly for young subjects, to tell them that they had better eat something before coming to the office.

Dr. Alfred Cowan, Philadelphia: All one needs to do to determine whether or not a cycloplegic is satisfactory is to measure the accommodation at the time of refraction. For the ordinary examination I use cycloplegics to help to determine the static refraction. It seems to me,

as Dr. Gipner brought out, that the interval of time employed by Dr. Bothman, that is, fifteen minutes after the last instillation of scopolamine hydrobromide, is rather short. I always wait longer than ten or fifteen minutes after the last instillation, of the fifth or sixth drop of homatropine hydrobromide. It is advisable to instill 1 or 2 drops in each eye in the evening. The next morning 6 or 7 drops are used at intervals of fifteen minutes, and the retinoscopic examination is made not sooner than half an hour after the last instillation. The accommodation is measured before proceeding with the refraction. If the residual accommodation is more than 1 or 1.5 diopters or even 2 diopters, I use another cycloplegic. But if good results can be obtained with a cycloplegic the effect of which lasts twenty-four hours, why should one be used the effect of which lasts ten days, even for a boy or girl 13 or 14 years of age?

BENZEDRINE IN CYCLOPLEGICS: II. A FURTHER REPORT. Dr. S. JUDD BEACH and DR. W. R. MCADAMS, Portland, Me.

This is the report of more definte data on the use of benzedrine with cycloplegics for refraction, certain advantages of which were pointed out previously. This possibility was suggested by a statement in a paper of Myerson's on the pharmacology of benzedrine, which claims that complete but temporary cycloplegia follows the use of benzedrine with atropine in attenuated solutions. The action which results is as though atropine inhibits the circular fibers of the ciliary muscle and benzedrine stimulates the radial fibers. Thus an intense dilatation of the muscle results, with corresponding relaxation of accommodation, but of shorter duration than when atropine is used again and again. We do not understand that it is the presence of benzedrine that hastens the recovery; it is rather the use of less atropine.

In our clinics the cycloplegia resulting from a single instillation each of benzedrine and atropine appeared to be essentially as complete as would be anticipated from a cumulative dose of atropine alone, and of vastly shorter duration. We also found a similar action with homatropine, which passed off with astonishing rapidity. Both drugs seemed satisfactory for refraction. Our experiments also indicate a synergism with scopolamine and with euphthalmine.

Results were gaged by retinoscopic examination, with the eye fixing at different distances, and more certainly, by comparing static refraction for distant and for near vision. With intelligent patients, amplitude was measured with a +3 addition at 33 cm. With homatropine the effect on one eye of a single instillation followed by the instillation of benzedrine was also compared with that on the fellow eye, produced in the orthodox way by multiple administrations of homatropine without benzedrine.

The present report compares the action of the two methods on the same eye. Single instillations of the cycloplegics with benzedrine were used first, and the effect was measured. When it had worn off, repeated doses without benzedrine were administered in the conventional manner.

Cycloplegia from benzedrine and homatropine is rapid. Often it is well advanced in from twenty to thirty minutes and at its peak in from fifty to seventy minutes. The fall begins soon, so that the examination should be under way within the hour. The recovery progresses rapidly, so that patients examined in the afternoon have claimed to read at 7

or 9 o'clock in the evening, and many by 11 o'clock. They can usually return to work the next morning. The effect from atropine and benzedrine is also likely to reach its height in an hour, but a small increase may continue for a half or three quarters of an hour longer. After its use, patients have read in one day, but ordinarily from two to four days are required.

We have found the benzedrine method especially useful in the care of out-of-town patients and in the clinic. When time is short, the action is quick. No potent drugs need be given incompetent parents. Systemic effect causes no anxiety. Cycloplegia is possible when a second visit cannot be made for examination and when a student or an adult must return to work immediately. Patients enthusiastically welcome the freedom from annoyance and the rapid recovery. When results are uncertain, the orthodox method can still be employed.

At present, it is our feeling that in critical cases prolonged atropinization is probably justified to compel the utmost reaction, although it is not as reliable as generally believed. In general, the gain over the benzedrine method is so slight and uncertain that it is doubtful whether it often compensates for the loss of time.

DISCUSSION

Dr. Hunter H. McGuire, Winchester, Va.: My conclusions, though based on a much more limited experience, are in entire accord with those of Dr. Beach. The distinct advantage of being able to induce complete cycloplegia under supervision in one's own office in the shortest possible time and the definite shortening of the period of recovery should appeal to both physician and patient. Thus far, my experience convinces me that the method will stand the test of time.

Dr. Conrad Berens, New York: Cycloplegia from benzedrine and homatropine is rapid. Often accommodation is markedly paralyzed within from twenty to thirty minutes, and in the majority of cases it is almost completely abolished in from thirty to sixty minutes. The residual accommodation did not exceed 0.25 D. in 70 per cent of 23 eyes studied. In this respect the results are similar to those obtained with the orthodox method of using atropine. The use of atropine sulfate in 1 per cent solution three times a day for three days caused a reduction of only 0.25 D. in accommodation when compared with one instillation of benzedrine and homatropine. After the use of the latter drug, most patients may use their eyes for reading within from three to six hours.

Filter-Passing Agent as a Cause of Endophthalmitis. Dr. Jonas S. Friedenwald and Clara McKee, Baltimore.

In a case of bilateral uveitis with papillitis the cell count in the spinal fluid was increased. On inoculation of an animal with the patient's spinal fluid a virus was secured which produced characteristic intraocular inflammatory lesions when inoculated into the eyes of rabbits, dogs and cats. The virus passes the Berkefeld V filter more readily than the Seitz filter. It can be cultivated on the chorioallantoic membrane of chick embryos and can be preserved for several months in anaerobically sealed Berkefeld filtrates of infected tissues and in glycerinated emulsions of infected tissues. The virus produces in rabbits lesions somewhat

similar to those produced by the virus of periodic ophthalmia of horses, but the evidence at hand would indicate that the two viruses were not identical.

DISCUSSION

DR. ALBERT L. BROWN, Cincinnati: The report lends itself to discussion on three subjects: (1) the virus as an isolated phenomenon, (2) its action on the eye and other organs and (3) its relation to the pathogenesis of human uveitis.

The case reported is apparently one of uveitis, albeit with certain unusual characteristics. The description of the eye suggests a composite of bilateral optic neuritis and generalized uveitis, which the authors wisely call endophthalmitis. In the absence of all other findings in the patient, a virus was isolated from the spinal fluid which survived many intraocular passages in animals. This may simply indicate that the vitreous is a favorable medium for the virus, but it does not necessarily prove that it has specific properties to produce ocular lesions. The ocular reactions in the various animals were all produced by direct intraocular injection. These reactions, especially in cats, seemed to be severe endophthalmic effects rather than any specific tissue entity seen in human beings. The lesions, especially those revealed by the microscope, were lodged variously in the retina, optic nerve and uveal tract. The predominant tissue effects depended on the species of animals used. Experimentally, the virus could not be said to produce any characteristic ocular pathologic entity.

PERSONAL EXPERIENCES WITH INTRACAPSULAR CATARACT EXTRACTIONS. DR. FREDERICK A. DAVIS, Madison, Wis.

This paper will appear in full in a later issue of the Archives.

OCULAR MANIFESTATIONS OF ENDOCRINE DISTURBANCE. DR. ALBERT M. LEMOINE, Kansas City, Mo.

This paper was published in full in the February 1938 issue of the ARCHIVES, page 184.

DISCUSSION

DR. A. D. RUEDEMAN, Cleveland: My own experience with endocrine disturbances has been rather unsatisfactory, for the simple reason that after a diagnosis is made there is little in the way of treatment to offer most of the patients. If I might offer some advice I should say that when one makes a diagnosis one should leave the door open just a little so that a second diagnosis can be made, for in most instances it is rather difficult to get a substantiation of one's conclusions. It is well known that there are few accurate tests for endocrine dysfunction and that when one does establish an accurate diagnosis there is little that can be done in the way of treatment. Few patients with hyperthyroidism, the one field I think that offers the most to the ophthalmologist, are seen when it is too late to help them much as far as the condition of the eyes is concerned.

There is a field, however, in which the ophthalmologist should play a part and that relates to acute hyperthyroidism in adults. Hyper-

thyroidism developing in an adult offers a diagnostic opportunity to the oculist, and the oculist usually misses it. A survey of a group of patients revealed that 75 per cent of those who had acute hyperthyroidism with progressive exophthalmos had been given glasses during the acute phase of the disease and during the progression of the exophthalmos. A taking of the pulse rate, or merely examination with Hertle's exophthalmometer, would have shown the operator that there was exophthalmos and that it was due to disease of the thyroid gland. The condition in such cases should be regulated by the oculist and not by the surgeon.

Dr. Charles A. Bahn, New Orleans: As knowledge increases, ophthalmologists are becoming less dogmatic about the role that specific dysfunction of the endocrine glands plays in the causation, aggravation or association of ocular symptoms. The following etiologic classification has been of service in my courses of instruction during the past several years: (1) ocular symptoms caused by endocrine dysfunction; (2) ocular symptoms aggravated by endocrine dysfunction, and (3) ocular symptoms associated with endocrine dysfunction, the causative relation being as yet undetermined.

The first group is illustrated by bronzing of the lids, more or less characteristic opacities in the cornea and lens, uveitis, retinitis and changes of refraction in cases of pancreatic diabetes; by pigmentation of the lids in cases of Addison's disease; by perinuclear opacities in cases of hypoparathyroidism, and by visual disturbances, with or without inflammation, involving the retina and the optic nerve in some cases of lesions of the pituitary gland.

The second group is illustrated by the increased severity of diseases of the uvea and of the retina and the optic nerve of different forms during menstruation, pregnancy and menopause; by the increased frequency of interstitial keratitis in cases of congenital syphilis associated with hypothyroidism, and by the increase of pyoderma of the lids during adolescence.

The third group is illustrated by the association of retinitis pigmentosa with polydactilism, obesity, genital underdevelopment and psychic changes, which together form the Laurence-Moon-Biedl syndrome. In this syndrome a form of congenital pituitary dysfunction is apparently involved. Another illustration is the association of conical cornea with the Fröhlich type of pituitary dysfunction; angioneurotic edema with adrenal insufficiency; blepharitis and premature presbyopia with hypothyroidism, and numerous congenital ocular defects, disease of the thyroid and other transmissible endocrinopathies.

Whether or not the foregoing examples are accepted in the order in which I have placed them is of minor importance. More important is that one learns to think of ocular symptoms of an endocrine nature in terms of causation, aggravation or association.

Further Studies on the Regeneration of the Aqueous in Man.

Dr. Peter C. Kronfeld, and Dr. C. K. Lin.

The intraocular tension of the human eye immediately after puncture of the anterior chamber depends on the relation between the volume of the anterior chamber and the volume of the entire globe.

The interval of time necessary for restoration of the intraocular pressure in the nearly normal human eye to the original level depends on the original volume of the anterior chamber. The rate at which new intraocular fluid is formed in the nearly normal human eye after puncture of the anterior chamber appears to be independent of the original volume of the chamber.

The intensity of the reactive ocular changes which follow puncture of the anterior chamber and manifest themselves as the hypertensive phase seems to be proportional to the intensity of the eliciting stimulus, that is, to the amount of fluid withdrawn.

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OPHTHALMOLOGY

CHARLES R. HEED, M.D., *Chairman*

Oct. 21, 1937

ALEXANDER G. FEWELL, M.D., *Clerk*

SUBCHOROIDAL HEMORRHAGE SURROUNDING THE OPTIC NERVE. DR. E. GIRARD SMITH.

The patient was admitted to the University Hospital on Oct. 14, 1937, complaining of distortion of objects seen with the right eye.

About September 1 the patient suddenly noted that objects viewed with the right eye were smaller than those viewed with the left eye. There were no other suggestive symptoms. Five months prior to admission he was in an automobile accident and was taken to another hospital, where a large gash over the right temple was sutured. Recovery was uneventful. On his admission to the University Hospital vision in the right eye was 6/30 and in the left eye, 6/6.5. Vision in the right eye through a pinhole was 6/15 — 2. A large scar was observed over the right temporal region. External examination of the eye gave negative results. Examination of the right fundus showed the media to be clear, the disk round and the margins fairly well outlined. Surrounding the inferior nasal and inferior temporal parts of the disk was a slate-colored area, extending outward approximately from 1 to 2 disk diameters. Surrounding this area were hemorrhages, which were striated and apparently in the deeper layers of the retina. The retina over the affected area was raised about 1.5 D., and there were traction bands running toward the macula. Roentgenograms of the skull were normal. The pressure of the spinal fluid was 170 mm. of water, and its protein content was 45.25 mg. per hundred cubic centimeters. There were no blood cells in the fluid. The blood was normal. With a 1 mm. white test object at 1,000 mm., the central visual field showed an enlarged blindspot, with a large cut in the temporal field. It was thought that the patient might have a chronic subdural hemorrhage, but examination by Dr. Francis Grant failed to disclose any signs of it.

This case is presented because of the diagnostic problem. The lesion of the fundus could be due to a sarcoma, but I believe this rather unlikely. I believe that the slate-colored area below the disk is due to blood in the subchoroidal space, which has traveled along the sheath of the optic nerve. It is interesting to note that the patient's accident, which is the only apparent factor to be considered, occurred five months previously. During the patient's stay in the hospital the hemorrhages in the deep retinal layers have gradually become absorbed and the subchoroidal hemorrhage appears to be traveling downward.

DISCUSSION

DR. FRANCIS ADLER: I believe that the condition is a subdural hemorrhage which came down the sheath of the optic nerve and finally presented itself at the disk. I am particularly interested to know what type of defect might arise in the visual field from such a lesion. It has been thought by some writers that the defect in the visual field in cases of choroiditis juxtapapillaris indicates that the disease involves the sheath of the optic nerve close to the disk and hence gives rise to defects in the nerve fiber bundles. Such defects were not found in the case reported here. The defect in the visual field represented an involvement of a large portion of the retina. It is rather curious how long it took the hemorrhage to make its appearance. As it spread out in the choroid it caused a flat detachment of the choroid and retina. It seems to me the only other diagnostic possibility is that of a tumor in this region, and the eye will have to be carefully watched.

DR. CHARLES B. HEED: Did I understand this lesion to be the result of hemorrhage or of clot?

DR. FRANCIS ADLER: The lesion is definitely composed of blood and is situated in the choroid. There is some fairly fresh blood toward the periphery of the lesion.

RETINAL DETACHMENT TREATED SUCCESSFULLY WITH THE THERMOPHORE: RÉSUMÉ OF FIVE CASES. DR. H. MAXWELL LANGDON.

In September 1934 a patient with detachment of the lower portion of the retina was operated on by means of sclerotomy for drainage of the subretinal fluid. A flap of conjunctiva was laid back and multiple applications of Shahan's thermophore, at a temperature of 165 F., were made into the sclera. The vision afterward was 5/9, with a full visual field, and has remained so for three years.

In November 1935 a patient with detachment of the complete lower half of the retina was similarly treated. The retina had been detached for four months before operation. Central vision was 4/60, and the entire upper visual field was lost. After the operation the corrected vision was 6/30, and the visual field was full. This improvement has been maintained to the present.

In February 1936 a patient was operated on at the Episcopal Hospital, in the service of Dr. Knox. He had a complete detachment of the upper half of the retina, with loss of the entire lower visual field; the central vision was reduced to the counting of fingers. After the operation the vision returned to 6/9, and the visual field was full, conditions which have remained to the present.

In June 1936, through the courtesy of Dr. H. L. Harley, a patient was seen with a detachment of the temporal portion of the right retina. Central vision was 3/60, and the nasal portion of the visual field was lost. Operation was performed on June 22, with the result that the upper half of the detached portion was replaced, but the lower portion was still detached. On July 2 the lower portion of the eye was again operated on; the retina, however, still remained detached. Central vision was not improved, but the lower portion of the nasal field was restored.

On March 8, 1937, Mr. D. G. H. was operated on for a detachment of the lower outer portion of the left retina, central vision being reduced to 5/15 and the nasal half of the visual field being lost. The operation resulted in a vision of 5/6 partly and a full field.

The operative results of 1 of these 5 cases have been successful for three years, in 1 for two years, in 1 for twenty-two months and in 1 for six months, while those in 1 case were unsuccessful.

Dr. Shahan has operated on a patient in this way, applying the heat first and performing sclerotomy afterward in order to maintain the intraocular tension while using the thermophore and also because heat applied to the sclera at 165 F. had been found to destroy the retinal cell elements. I have not found it difficult to use the thermophore after sclerotomy. I do not see how destruction of some of the retinal cells can be avoided, if there is sufficient reaction to throw out enough exudate to produce adherence of the retina to the choroid.

Dr. John Green has used the thermophore at 153 F. after making three trephine holes in the sclera. If this temperature is sufficient to bring about a choroidal reaction, it should be used rather than the higher temperature which I have used. The trephining seems to be superfluous, as the heat will readily pass through the sclera and the subretinal fluid may more easily be evacuated by sclerotomy.

The patient should be kept in bed for at least two weeks after operation with both eyes bandaged for a week, as the adhesions should be given sufficient time to organize fully, and stenopeic spectacles should be worn for four weeks more.

DISCUSSION

DR. WARREN S. REESE: Did I understand Dr. Langdon to say these were the only cases in which he has used this procedure?

DR. WILLIAM ZENTMAYER: Did any of the patients have myopia?

DR. H. MAXWELL LANGDON: These are the only cases in which I have used this procedure. The only other cases, to my knowledge, in which it has been used were those of Dr. Shahan and Dr. Green. The fifth patient in this series had only 1 diopter of myopia. I feel that this method would be as efficacious in cases of myopia as any other method.

BUPHTHALMOS WITH NAEVUS FLAMMEUS. DR. CARROLL R. MULLEN.

Naevus flammeus associated with glaucoma is of rare occurrence. About 67 cases have been reported since this condition was first described by Schirmer in 1860.

An excellent and most complete review of the reported cases was presented in 1933 by Dr. Cecil O'Brien and W. C. Porter, of the Uni-

versity of Iowa. More recently, Mehney, of the University of Michigan, covered the known evidence of this condition in reporting an additional case.

It will not be necessary to digest these reviews because the published reports are readily available and remain rather fresh in one's mind from repetition in the past four years. Briefly, it may be pointed out that glaucoma can be looked for in cases of facial nevus which involves the lids, the conjunctiva, the episclera, the iris, the choroid or other ocular structures. It is usually of the infantile type, of which Drs. O'Brien and Porter found 38 instances in their total of 56 known cases. Unilateral glaucoma has been noted in practically all cases. Intracranial changes are often associated with this condition.

T. B., a white woman, aged 22, a native and resident of South Carolina, presented herself at the clinic of Dr. Thomas A. O'Brien at the Wills Hospital during August 1937. She was mentally alert and appeared equal to persons of her age. According to her history, a port wine birth mark and protrusion of the right eye had been present since birth. She never recalled vision being present in this eye, nor did it ever pain her, although she observed that at times it "aches and feels tight."

The patient had three brothers. There was no history of nevi appearing in any member of her family, and none of her immediate relatives had trouble with their eyes. In 1931 or 1932 she received four or five treatments with radium, but no effect on the nevus was observed.

There was no perception of light in the involved right eye. Visual acuity in the left eye was 6/9+4.

The external examination showed a port wine nevus involving the right half of the face, including the eyelids, the nose and the upper lip. The right eyeball was enlarged; it protruded and diverged 30 degrees. Tension of this eye was recorded as 66 mm. of mercury (Schiötz) and checked with two weights. With an exophthalmometer, the position of the right eye measured 35 mm., and that of the left eye, 13 mm. There were some slight upward, downward and lateral excursions of this eye, but it could not rotate medially past its midline. The cornea of the right eye measured 15 mm. in transverse diameter, and that of the left eye, 10 mm. The cornea was conical; the anterior chamber was deep, and the pupil was well dilated and fixed.

External examination showed the left eye to be apparently normal. With the confrontation method, the visual fields were full and normal.

Ophthalmologic study of the right eye showed some central corneal changes and many fine linear, closely packed lenticular opacities, which extended from the periphery of the lens to meet at its center. A red reflex was present, but because of the haze in the media details could not be made out other than that the disk appeared to be pale. Cupping of the disk could not be determined.

Examination of the right eye with the slit lamp showed several small opaque deposits in the center of the cornea and the presence of lenticular opacities. The anterior chamber was deep.

In confirming the diagnosis of naevus flammeus, Dr. Joseph V. Klauder stated that in twelve years at the Wills Hospital he had never before observed this condition associated with glaucoma.

The roentgenographic examination by Dr. Spackman disclosed the right orbit to be enlarged and slightly deformed. A peculiarity in the formation of the right frontal sinus was noted. He also observed that the general architecture of the skull appeared to show a tendency to congenital deformity. The sella turcica was unusually small and underdeveloped. The optic canals were slightly smaller than usual but equal and symmetrical on the two sides. The sinuses were all clear except the right maxillary sinus, which showed increased density.

Dr. John Reese, on examination of the nose and throat, noted infected tonsils but no clinical evidence of sinal infection. He believed the nevus responsible for the cloudiness observed in the roentgenogram in some of the cells of the sinuses on the right side. The nevoid process terminated about midway down the posterior pharyngeal wall.

Both the Meinicke and the Wassermann reaction were negative, and the chemical composition of the blood was within normal range.

SUPERFICIAL PUNCTATE KERATITIS: ITS TREATMENT WITH IODINE SOLUTIONS. DR. ALFRED COWAN and DR. THOMAS H. COWAN.

This article appears in full in this issue of the ARCHIVES, page 709.

PAPILLITIS SECONDARY TO IRIDOCYCLITIS. DR. WILFRED E. FRY.

The condition described here represents a type of change in and about the disk associated with severe inflammation of the anterior segment of the eye. Such inflammation may be corneal ulceration, iritis or iridocyclitis. The changes in the anterior segment do not necessarily have to be prolonged, and in this case the inflammation was not of particularly long standing.

The patient, a 78 year old woman, first complained of an inflamed right eye on April 11, 1935. Two days later, when she first consulted a physician, drops were given. Nine days later, when she was first seen by me, there was a large ulcer of the lower inner section of the cornea. She was immediately hospitalized.

The general examination gave negative results except for hypertension (blood pressure, 230 systolic and 100 diastolic) and albuminuria, with a few fine granular casts.

In spite of treatment, consisting of subconjunctival injections of Pregl's solution (the solution resulting from the action of iodine on sodium carbonate solution) as well as local applications and injections of milk intramuscularly, the condition became worse, and the right eye was enucleated on April 29. A section of the eye showed dense corneal infiltration and an area of perforation, which occurred at the time of operation, dense infiltration of the iris, inflammatory occlusion of the pupil, markedly dilated choroidal vessels and a subretinal space into the papilla. The fibers of the lamina cribrosa sclerae retained their normal contour. The retina, except close to the papilla, retained a relatively normal structure.

I believe that this condition is papillitis, although other diagnoses must be considered: first, a choked disk from increased intracranial pressure; second, a choked disk associated with hypertensive retinitis, and third, edema of the papilla from ocular hypotony.

READING DIFFICULTIES IN CHILDREN. DR. GEORGE E. BERNER.

DISCUSSION

GLADYS G. IDE, PH.D.: Dr. Berner has presented the problem of children who have difficulty in reading, the cause of which probably is a defect in vision.

A certain group of children having ocular defects and good mentality are able to make accommodation to visual defects even though these defects may be serious. They will also learn to read even under the most adverse circumstances.

Most children, however, do not have a good enough mentality to be able to learn to read with a bad visual defect. The need for accommodation is not recognized, and the child fails because he does not know how to make use of his poor visual equipment to the best advantage. Neither will he try, as I have seen a child try, to accommodate when an appreciable amount of time is required for him to focus his hyperopic eyes on a stimulus. Few children can endure the strain or discover for themselves what must be done in order to secure a definite image. The plea which the educator makes to the ophthalmologist is on behalf of those children who must be adjusted to the school requirements and who are unable to meet these requirements because of poor vision. About 10 per cent of the ordinary dull children entering school are unable to profit by school instruction in reading because of poor vision.

DR. WILLIAM ZENTMAYER: Would it be feasible, advisable or useful to have the lines printed alternately from left to right and right to left?

DR. GEORGE E. BERNER: The printing of lines in alternate directions has been done, not, I believe, for the teaching of reading but as an experiment to see if good readers would receive any benefit in the way of more rapid reading and relief from eyestrain. What the results were, I do not know, but certainly it would be a method adaptable only to a person with an extremely wide range of visual attention and could never be used for the ordinary "newspaper type" of reader.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

JAMES W. WHITE, M.D., *Chairman*

Oct. 18, 1937

RUDOLF AEBLI, M.D., *Secretary*

RESULTS OF CORNEAL TRANSPLANTATION. DR. RAMON CASTROVIEJO.

More than 100 corneal transplantations have been performed during the past four years at the Institute of Ophthalmology, Medical Center.

The shape of the transplant as well as different steps of the technic have been altered repeatedly in order to find the procedure which would give the best results in the highest percentage of cases. Occasionally modifications of the technic had to be introduced to suit particular instances. Marked improvement in vision was obtained in over 40

per cent of the unselected cases in which corneal transplantation was performed. Of the favorable cases in which this procedure was carried out, a transparent corneal graft was obtained in over 70 per cent, with marked improvement in vision, varying from perception of hand motion to the counting of fingers at from 1 to 4 feet (30 to 122 cm.) before the operation to from 20/200 to 20/20 afterward.

Corneal transplantation, in the present state of knowledge, does not offer a much greater operative risk than an operation for cataract. The results obtained with corneal transplantation can be favorably compared with those obtained with other operations universally accepted and routinely practiced by ophthalmic surgeons.

DISCUSSION

DR. ERNST WALDSTEIN: May I ask whether corneal grafting is more likely to produce better results in some conditions than in others? Have Dr. Castroviejo and his associates found that this procedure gives better results in cases of corneal opacity following parenchymatous interstitial keratitis than in cases of opacity following, say, a burn from lime?

DR. RAMON CASTROVIEJO: When a transplant is to be entirely surrounded by dense scar tissue, the transplant seldom remains transparent. It generally becomes either nebulous or opaque.

The transplant remains transparent in a high percentage of cases of parenchymatous keratitis, in which as a rule a good deal of normal or almost normal corneal tissue is preserved.

A corneal leukoma following a burn from lime or similar types of injury is generally unfavorable for keratoplasty, on account of the extreme density of the leukoma and the presence of superficial blood vessels, resembling those observed in cases of severe trachomatous pannus. A preliminary operation should be performed to remove the vessels from the cornea. Otherwise, the transplant becomes either nebulous or opaque.

MELANOSARCOMA OF THE IRIS: REPORT OF A CASE. DR. BERNARD FREAD.

A man aged 77 complained of decreasing vision for a year and recent pain in the right eye. The eye was blind. Transillumination gave a normal picture. Iridectomy failed to keep down the increased intraocular pressure, and the eye was enucleated because of pain. Routine pathologic examination revealed melanosarcoma of the iris. The growth recurred in the orbit ten months later, exenteration of the orbital contents being necessary.

LESIONS OF THE OPTIC NERVE. DR. FRANK D. CARROLL.

Three cases of lesions of the optic nerve are presented:

CASE 1.—A 65 year old woman had a hole on the temporal side of the optic nerve about 7 D. in depth. The nerve appeared grayish white. A small branch of the superior temporal artery curved into the hole and out again. Corresponding to the hole in the papillomacular bundle there was a defect in the visual field extending almost to the point

of fixation. The visual acuity was 20/30, and opacities of the lens were sufficient to account for this reduction in vision. Below the disk in the area sometimes occupied by coloboma of choroid there was a marked pigmentary disturbance, with a corresponding defect in the upper part of the visual field. The fundus of the other eye was normal.

CASE 2.—A patient with Leber's disease belonged to a family in which at least 6 other members had the same condition. The age of onset in this group varied from infancy to past middle age, and the visual acuity, from 20/50 in each eye to almost blindness.

CASE 3.—A woman aged 22 had sudden loss of vision in one eye, so that she could see only hand movements. The margins of the disk were slightly blurred in that eye. In one month the visual acuity and the visual fields were normal without any treatment. Four years later she had a similar attack in the other eye, which cleared up without treatment in ten days. Neurologic examination indicated probable multiple sclerosis. When one attempts to evaluate some newly suggested treatment which is supposed to hasten the speed of recovery in such cases, it is well to remember the normal course of the disease without treatment.

DISCUSSION

DR. ARNOLD KNAPP: When was the visual disturbance discovered in Dr. Carroll's first case, and has it remained stationary?

DR. RAMON CASTROVIEJO: Since Dr. Carroll has been so greatly interested in the study of lesions of the optic nerve, perhaps he has had some experience with the treatment recently advocated by Lauber for atrophy of the optic nerve.

Lauber claims that improvement is obtained in such cases by raising the arterial blood pressure and lowering the intraocular tension by the instillation of myotics.

Dr. Arruga recently reported some cases in which great improvement followed the treatment advocated by Lauber.

I have been treating several patients with atrophy of the optic nerve during the past few months according to Lauber's suggestions, but so far there has not been any improvement, either in the ophthalmoscopic appearance or in the vision.

Since Dr. Carroll stated that in some cases lesions of the optic nerve improve without treatment, perhaps the improvement observed in some of the cases in which Lauber's method has been used could be attributed to the normal evolution of the condition and not to the treatment itself.

DR. WALTER F. DUGGAN: I have treated several patients with frank atrophy of the optic nerve. The only one I particularly recall was a man aged 27 with multiple sclerosis, who said that the vision of his right eye had been poor for three years. The vision was 20/100—, and he had a definite paracentral scotoma with a sloping edge. I prescribed intravenous injections of a solution of sodium nitrite and assumed that he would have from six to twelve doses, and then if he showed no improvement that the therapy would be stopped. I was away from the clinic for a considerable length of time, and when I returned I found that he had received thirty injections; after the fourteenth injection his vision had improved to 20/50. The final vision was 20/30—, which

was maintained for a year after treatment. This is an example of marked improvement in a case of atrophy of the optic nerve. I think that the improvement was due to the fact that the scotoma was small and had a sloping edge. I am certain that the treatment improved the vision, because the patient gave a history of having had poor vision for three years before he was treated. This treatment of atrophy of the optic nerve is diametrically opposite to Lauber's treatment, since the blood pressure is lowered instead of raised.

DR. FRANK D. CARROLL: The patient in case 1 did not complain of disturbance of vision in the eye which had the hole in the optic disk. She was unaware of the defect in the visual field. She complained only of disturbance of vision in the other eye, which had the cataract. The visual acuity in the eye with the hole in the optic disk was 20/30. In looking over the literature, I found that in most of the cases there was no defect in the visual field corresponding to the hole and that most of the patients had good vision. Some of them, however, did have defects in the visual field, as occurred in the case reported by me. Holes sometimes occur in patients who have a frank coloboma of the disk, and I assume that this condition is much the same.

In reply to Dr. Castroviejo, I have treated only a few patients by the method suggested by Lauber. However, I have treated them a little differently; in cases of bilateral lesions I have employed miotics in only one eye, using the other eye more or less as a control. I have not seen any difference in the improvement in either eye.

MIXED TUMOR OF THE LACRIMAL GLAND. DR. RICHARD T. PATON.

A white man aged 22 had had an intermittent swelling of the left upper lid for a year. There had been convergent strabismus and amblyopia of one eye since childhood. The eye on the side of the tumor showed a flat detachment of the retina, which receded after removal. Strabismus was corrected one year later. There was no recurrence of the tumor after three years.

DISCUSSION

DR. ALGERNON B. REESE: The detachment of the retina in Dr. Paton's case is a most unusual complication. I wonder if it could have been due to an indentation of the sclera by the tumor. An orbital tumor sometimes pushes the sclera in, rather than the eye out. This would account for the slight amount of exophthalmos present.

DR. ARNOLD KNAPP: Pressure on the eyeball by an orbital tumor, as described by Dr. Paton, is a symptom described by Dimmer some years ago in his book on ophthalmoscopy. It is particularly pressure which is exerted literally on the eyeball, so that the eyeball cannot elude it, which causes a depression of the sclera, with detachment of the choroid and the characteristic wrinkling of the retina.

DR. DAVID WEXLER: Mixed tumors containing the elements which were reported in Dr. Paton's case may be highly malignant. Several years ago Dr. Isadore Goldstein and I reported a case of proptosis in a young man which was caused by a mass arising from the great wing of the sphenoid (Tumor of the Orbit in a Case of Osteochondrofibrosarcomatosis, ARCH. OPHTH. 21: 201 [Aug.] 1934). The tumor

was a rapidly growing fibrosarcoma, containing, in addition, immature cartilage and bone. However, it was but one of numerous malignant growths arising from various parts of the skeleton (sternum, ribs, vertebrae, pelvis and skull) and resulting in death. Tissues in the tumor were embryonal and probably resulted from sudden growth of the undifferentiated elements in various areas.

DR. RICHARD T. PATON: In answer to Dr. Reese's suggestion that the detachment was due to pressure, I think that is correct.

ADIE'S SYNDROME. DRS. FOSTER KENNEDY, HERMAN WORTIS, JOHN REICHARDT and BAXTER B. FAIR.

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ROYAL SOCIETY OF MEDICINE, SECTION OF OPHTHALMOLOGY

London, England, Nov. 12, 1937

MR. W. H. MCMULLEN, O.B.E., F.R.C.S., *President*

PLASMOCYTOMA OF THE LACRIMAL GLANDS. MR. S. T. PARKER, F.R.C.S.

Plasmocytoma of the lacrimal gland is rare. A report of the case on which this presentation is based follows: A man aged 66 sought advice because he and his friends noticed that his left eye appeared to be gradually closing. This had been first observed ten months previously. Examination disclosed ptosis and some undue prominence in the outer half of the supraocular sulcus. The marginal portion only of the upper eyelid was capable of slight voluntary movement. On digital examination there was revealed a firm, somewhat lobulated subcutaneous swelling, which seemed to be extending from the fossa for the lacrimal gland. All the ocular movements were free; there was no diplopia; vision was 6/6 unaided, and the fundi and media were apparently normal. Tumor of the lacrimal gland seemed to be the most likely diagnosis; this was confirmed at operation a few days later. The lacrimal gland, which was enlarged to about two and a half times its normal size, was removed without great difficulty. It was grayish brown, slightly lobulated, firm and encapsulated. At one point the capsule was thin and seemed torn. The bony upper wall of the orbit appeared to be normal, and a portion of gland seemed to remain. The patient made an uneventful recovery.

Microscopically, the tumor was found to be a cellular nodule of tissue, and there was a definite attempt at encapsulation by means of fibrous connective tissue. Fibrous tissue trabeculae, many of them thick and solid, entered the substance of the nodule from this capsule and, intersecting in the substance, divided it into lobules. Many well formed blood vessels accompanied these septums, but few were seen in or among the actual masses of tumor cells. No areas of degeneration or necrosis were seen. The cells were indistinguishable from plasma cells. They

had undergone slight distortion as a result of fixation but were, roughly, oval or circular. The cytoplasm of the cells appeared amorphous. One or two nucleoli were to be seen in most of the nuclei. Mitotic figures were scarce. Underneath, the tumor was a plasmocytoma.

For the first six months after the operation no sign of recurrence was detected, and the patient resumed his normal life, that of a farmer. Gradually the inner half of the supraocular sulcus became obliterated by a second swelling, of similar size and consistency. After a year, another new growth, slightly less in size than the first, was removed. This was adherent to the frontal bone, with some erosion of the floor of the frontal sinus. After the removal of the mass, the surrounding area was cauterized freely by means of diathermy. A good recovery ensued, but the patient suffered from troublesome diplopia, on account of the damage to the superior oblique muscle. As a number of observers have noticed good results from the application of radium, this form of therapy was used six weeks after the second operation, and no further recurrence was noticed until the lapse of eleven months. In July 1937 a tumor as large as that first observed was seen, and again radium was tried, the needles being inserted more deeply. There has been no recurrence so far. The rest of the skull, long bones, spine, ribs and sternum appeared normal. The Wassermann reaction was negative. Tests of the urine, especially the Bence Jones albumose test, gave negative results, and the blood was normal.

In the past the term plasmocytoma has been used to describe any form of tumor, either neoplastic or inflammatory, which was composed of plasma cells. The distinctive features of the plasma cell, as seen under the microscope, are: a large cell (up to three times the size of a lymphocyte), either oval or polyhedral. The cytoplasm is clear and seems to take more of the stain peripherally. The nucleus is eccentrically placed, with deep basophilic staining of its chromatin content, radiating in cartwheel form and condensed beneath the nuclear membrane. The size of the nucleus varies. A clear crescentic perinuclear zone in the cytoplasm is definitely demonstrated by staining with hematoxylin.

The origin of the plasma cell is unknown; many think it arises from a lymphocyte. Another theory is that it originates from fibroblasts, arising in the endothelial lining of the blood vessels.

The condition is rare in females and may appear in a medullary or an extramedullary form. Twelve cases have been described, in which the differential white cell count showed, on the average, 20 per cent of plasma cells. In all, the high percentage of these cells was associated with diffuse infiltration in various parts of the bone marrow of the skeletal system, owing to plasmocytoma. Half the cases of myelomatosis are cases of plasmocytoma.

The facts that the condition is sometimes associated with positive evidence of syphilis or tubercle and that plasma cells have been found in cases of chronic inflammatory conditions have led some observers to consider these tumors of an inflammatory origin.

Any kind of neoplasm of the lacrimal gland is a comparative rarity, but there is a possibility that some neoplasms described as lymphosarcoma are of this nature.

The present knowledge of the histologic picture of this condition, so far as the lacrimal gland is concerned, does not support the theory that plasmocytoma is of lymphocytic origin but is a type of endothelioma.

DISCUSSION

MR. BASIL GRAVES: A patient was admitted to the Royal Westminster Ophthalmic Hospital in 1934 with a history of having had a recurrent tumor along one of the rectus muscles. Operation had been performed at another hospital. The pathologist's report was that the tumor was a plasmocytoma.

BRITISH OPHTHALMOLOGY IN THE SIXTEENTH AND SEVENTEENTH CENTURIES. MR. ARNOLD SORSBY.

In this freely illustrated paper it is sought to deal justly with the authors of earlier works on ophthalmology, and praise is given where it had long been withheld.

DEFECTIVE MOVEMENTS OF THE LEFT EYE. MR. N. RIDLEY (for Mr. Affleck Greeves).

A boy aged 7 years was seen in the outpatient department in February 1937, after he had struck his eye on a door handle four days previously. Since the accident he had had double vision, one image being above the other. After the accident he vomited and had severe headache but did not become unconscious. Vision in this eye was 6/9; that in the right eye was 6/6. There were absence of upward movement and marked limitation of downward movement. Lateral movements were associated with jerkiness, but it was not true nystagmus. Dr. Purdon Martin, a neurologist, thought that the condition was due to a small hemorrhage at the apex of the orbit. No fracture was evident in the roentgenogram. In the last eight months the movements have become almost normal.

DEEP STAIN OF THE CORNEA: ARGYROSIS FROM STRONG PROTEIN SILVER. MR. FRANK JULER.

An engineer aged 24 had a toy pistol explode in his face in August 1936, and he received multiple foreign bodies in each eye. Drops of a 2 per cent solution of strong protein silver were used twice daily in each eye from November 1936 until September 1937. A fortnight ago vision was 6/5 partly in each eye; the eyes are now quiescent, except for a slight conjunctivitis. Examination showed a definite silver staining of the lower parts of the conjunctiva and of the caruncle. There was a metallic fragment in the posterior layers in the 4 o'clock position, which had a glistening, yellow, rusty appearance. In an arc around it was a definite opacity, confined to the posterior layer of closely packed points. These showed a diffuse deep blue color, which was most marked in the parts of the half circle nearest the limbus. The question which arises is whether the blue color is due to the foreign body or to a silver staining associated with superficial argyrosis. There are cases in which argyrosis has involved Descemet's membrane, causing a more or less diffuse blue staining.

MELANOTIC SARCOMA OF THE LIMBUS TREATED BY EXCISION FOLLOWED BY RADIUM THERAPY. MR. E. KEITH LYLE.

A man aged 60 was seen at the hospital in April 1937. Fifty years ago his right eye was splashed with hot fat; this left an opacity on the white of the eye. The opacity gradually spread over the front of the eye in the form of a film and interfered with vision; in the last two years it had become larger. On examining the right eye there was visible a large, raised darkly pigmented plaque, extending over the outer half of the cornea, apparently originating from the limbus in the 9 o'clock position. There were numerous distended blood vessels running into the growth in its lower part. The pupil was active, the tension was normal and the fundus and media were normal. The left eye was normal in every respect. In May the growth was excised; it stripped off the cornea easily, but was more adherent in the limbal region. The conjunctiva over the growth in this region was also excised. In June the patient was given a surface application of radium at the Radium Institute, and in September a similar treatment was administered. Microscopic section of the growth showed it to be a melanotic sarcoma of the limbus arising from nevus cells. It was proposed to give the patient one more application of radium.

DISCUSSION

MR. W. H. MCMULLEN: This is a particularly good clinical result up to the present.

NEOPLASM OF THE LEFT OPTIC NERVE (?). MR. KEITH LYLE.

A woman aged 50 was first admitted to the hospital in July 1937, with the complaint that nine weeks previously she commenced to see double. This lasted for thirty-six hours, the two images being seen side by side. Then the left eye became painful, with pain radiating over the left side of the head, down the left side of the nose and into the upper lip. A gradual deterioration in the sight of the left eye ensued, until complete blindness resulted. In 1922 she had undergone salpingo-oophorectomy on account of an ovarian cyst on the right side. Five years later she had pelvic peritonitis, and three years after that colpoperineorrhaphy and subtotal hysterectomy were performed, but there was no evidence of the presence of a neoplasm of the uterus. Examination for the cause of the present complaint showed that the pupil of the right eye reacted briskly to direct light but was consensually inactive. The optic fundus and the visual fields were normal. There was pallor of the left optic disk, the eye was painful to pressure and on movements, and there was a restriction of these movements laterally. There were slight ptosis and proptosis of the left eye. Roentgenographic examination disclosed nothing abnormal in the skull and the orbits. Expert examination of the nasal sinuses, throat and ears gave negative results. The Wassermann reaction of the blood was negative. The blood count showed: red cells, 4,700,000; hemoglobin, 90 per cent; white cells, 7,000; polymorphonuclears, 62 per cent; lymphocytes, 31 per cent, and eosinophils, 1 per cent.

DISCUSSION

MR. L. H. SAVIN: The late James Collier described under the title of inflammatory periostitis in the sphenoid fissure a condition which seems similar to the condition reported here, and at a meeting of the neurologic section of this society he presented a number of cases. The condition reported by Mr. Lyle may possibly be of the same nature.

MR. KEITH LYLE: At no time did this patient show evidence of inflammation, and there was never any chemosis. Pain is difficult to evaluate. The patient's daughter thinks that her mother makes the most of her symptoms, and perhaps the pain was not so severe as one was led to believe. The complete loss of vision in that eye suggests a lesion inside the optic nerve or a lesion which has led to complete destruction of that nerve.

DETACHMENT OF THE INTERNAL LIMITING MEMBRANE OF THE RETINA. MR. T. G. FENTON.

A woman aged 23 in February 1937 had an attack of acute juxtapapillary choroidoretinitis, for which no extraocular cause could be found. At the last examination the condition had reached a quiescent stage. There was an atrophic area of retina above and on the temporal side of the optic disk, with a corresponding wedge-shaped defect in the lower portion of the nasal visual field. The internal limiting membrane of the retina had become detached and lay in the vitreous close to the posterior surface of the lens, appearing as a thin, transparent membrane, with a round perforation representing the deficiency of this membrane at the optic disk.

DISCUSSION

DR. A. J. BALLANTYNE, Glasgow, Scotland: It is difficult to understand the internal limiting membranes, coming forward, as in this case, in a comparatively healthy vitreous. When the ophthalmoscope was focused on the summit of this membrane there was no surface reflex, but if one focused through it to the retinal details behind, there was the usual retinal surface reflex, which is supposed to come from the anterior limiting membrane.

MR. EUGENE WOLFF: This condition is what is usually described as detachment of the hyaloid membrane. In pathologic conditions, I have seen the membrane even at the back of the lens.

MR. RANSOM PICKARD: I have difficulty in accepting this membrane as the internal limiting membrane, because allowing for the hole corresponding to the disk it does not appear as uniform as one would expect it to be. I think that if the acute condition is a parachoroidal inflammation there would be opacities of the vitreous.

FILARIA BANCROFTI IN THE INTERIOR OF THE EYE. MR. MCMULLEN.

A man aged 25, an Indian student, was first seen on Sept. 8, 1937, on account of an inflammation in the left eye of six days' duration. At that time he was being treated by roentgen irradiation for spondylitis, from which he had been suffering intermittently since he was 10 years old. No definite cause for that trouble has been found. A year previously he had inflammation of the left eye, which was diagnosed as iritis; this

lasted for fourteen days. When the patient was seen by me the eye was much injected and the aqueous was slightly cloudy, with many floating particles. The pupil dilated well with atropine. The patient suffered from intense pain, and treatment with leeches was ineffective. During examination with the slit lamp there suddenly came into view in the aqueous a minute wormlike object, actively motile and thin. After a few seconds it disappeared. In October the signs of inflammation had almost subsided, but the slit lamp again showed a nematode worm. Colonel Wright examined the patient and agreed that it was a worm. The patient was admitted into the Hospital for Tropical Diseases, under the care of Dr. Cruickshank, who reported that microfilarias (Filaria bancrofti) were present in the night blood in fair numbers. The cutaneous test for filarias gave negative results.

DISCUSSION

MR. T. G. FENTON: I had a similar experience. A patient from West Africa complained of irritation in the eye. One saw a worm ¾ inch (1.9 cm.) long wriggling about just above the limbus, under the conjunctiva. After instillation of cocaine hydrochloride into the eye, only the tail end of the worm was seen. The conjunctiva was cut down, and the worm was caught by the tail with difficulty and extracted. After the use of the cocaine, it began to move quickly.

MR. T. HARRISON BUTLER: I published a report of a case of infection with Loa loa, in which the appearance was the same as in this case. The patient was a physician from West Africa, and he said that cocaine must not be used, as it would drive the worm away. The worm was 1 inch (2.5 cm.) long.

MR. W. H. MCMULLEN: I understand that these subconjunctival filarias are usually Loa loa, differing from Filaria bancrofti.

GERMAN OPHTHALMOLOGICAL SOCIETY

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DOCENT DR. MAX BÜCKLERS, TÜBINGEN, *Reporter*

Fifth Scientific Session

Wednesday, July 8, 1936, 3 p. m.

PROF. HANS LAUBER, *Chairman*, WARSAW, POLAND

(Concluded from Page 648)

DIAGNOSIS AND TREATMENT OF PARATHYROID INSUFFICIENCY. DR. FRIEDRICH HOLTZ, Berlin.

Often the typical phenomena of tetany, such as paresthesia and cramps, are missing, and the disturbance is manifest by varying clinical

symptoms. Among them are asthenia; rapid tiring; psychic disturbances; migraine; syncope; typical epileptic attacks; angina pectoris; vasomotor disturbances; a multiplicity of cutaneous changes, such as herpetiform impetigo, and irregularity in defecation. The diagnosis is based on the titer of the serum calcium (normal value, from 9.5 to 11 mg. per hundred cubic centimeters), the response to mechanical stimuli (Chvostek and Trousseau signs) and the response to galvanic current. Lenticular opacities are common (tetany cataract), so that slit lamp examination may give valuable and early evidence for the recognition of parathyroid insufficiency. This is of practical importance, as the systematic administration of irradiated ergosterol brings about relief from all symptoms and makes the patient fully able to go back to work.

INFLUENCE OF IRRADIATED ERGOSTEROL ON EXPERIMENTAL TETANY IN RATS. DOCENT DR. WALTER RAUH, Leipzig.

Irradiated ergosterol has been found by Dr. Holtz to contain a product which, like the parathyroid hormone, induces hypercalcemia and prevents the outbreak of acute tetany and/or cures it if already present. The preliminary report is based on 46 rats which were subjected to operation. Eleven of the animals were given irradiated ergosterol before the operation, and 35, subsequent to it, after a varying interval of time. Tetany developed in all of the 11 rats, and 2 died during the attack. Of the surviving 9 rats, 4 presented typical vacuolar cataract, while 5 showed only punctate cataract, which retrogressed considerably in the course of time. Nineteen of the animals received irradiated ergosterol from sixty-five to forty-eight hours before operation. One died in an acute attack; a slight vacuolar cataract developed in 1, and 17 retained clear lenses. Sixteen of the animals were given irradiated ergosterol from thirty-five to five hours before operation. Vacuolar cataract developed in 2 and punctate cataract in 2, while 12 showed transparent lenses. The animals were kept under observation for from forty-six to thirteen days. These data indicate that irradiated ergosterol given in sufficient and timely doses before extirpation of the parathyroid glands can be relied on to prevent the development of lenticular opacities. Administered shortly after the outbreak of the first spontaneous attack, it will prevent punctate opacities of the lens from developing into vacuoles.

CALCIUM METABOLISM AND THE EYE. PROF. ALOIS MEESMANN, Kiel.

With the aid of irradiated ergosterol, one can accurately regulate the height of the blood calcium in cases of hypofunction of the epithelial bodies. Lenticular changes were noted in 13 of a group of 24 cases of tetany, postoperative as well as genuine. In addition to the well known picture of flattening of the lens in its sagittal diameter, with the development of opacities, which were at first subcapsular, 3 adults showed at an early stage subcapsular spokes (*Reiterchen*) arranged in accordance with the course of the peripheral lamellae of the lens. In the cases of genuine tetany there were found also convincing transitional forms of lenticular opacities in all stages up to true zonular cataract. So far, treatment with irradiated ergosterol in these cases has brought the development of

cataract to a standstill for as long as three years, and it has been necessary to operate in only 2 cases in which the condition was far advanced. The flattening of the lens in its sagittal diameter caused a marked decrease in refraction in 1 case, and at the height of the attack a peculiar visual obscuration of high degree was repeatedly observed without any decided changes being detected ophthalmoscopically. In 2 cases of osteitis fibrosa hypercalcemia caused in an otherwise sound eye an extensive change in the limbus, like the white limbus line, which extended far back into the cornea, and calcification of the sclera, which in 1 case could be studied microscopically. In 1 case of cataract associated with glaucoma and aphakia in one eye and good vision in the other eye an overdose of irradiated ergosterol, taken because of a misunderstanding on the part of the patient, was followed by calcification of the entire lower half of the cornea, which cleared almost completely after the blood calcium had returned to normal. A follow-up study of 32 patients with zonular cataract showed increased irritability to electric stimuli in 69 per cent and dental changes in 56 per cent. According to the current conceptions, these dental changes are due to a lowered function of the epithelial bodies in addition to a deficiency of vitamin D. The calcium level was normal, except in 1 case. In 18 cases of congenital cataract symptoms indicating latent tetany were found only once. In 20 cases of coronary cataract and in 14 of posterior lamellar cataract an increase of irritability to electric stimuli, with otherwise normal findings, was noted with striking frequency, whereas in none of 60 cases of true senile cataract were there indications of latent tetany. In view of the extraordinary differences in the frequency of tetany in various parts of Germany and the practical importance of the treatment of lenticular opacities with irradiated ergosterol, a study of the various forms of cataract should be taken up anew. The general practitioner must become familiar with the early abortive forms of tetany cataract in order to examine patients with such cataracts for evidence of latent tetany and to make use of efficacious treatment with irradiated ergosterol. The protean symptoms of latent tetany often result in the diagnosis being overlooked. Even mild tetany, however, may end fatally in ileus or cardiac tetanus. The cooperation of the ophthalmologist is, accordingly, of essential importance.

Discussion on Papers by Dr. Holtz, Docent Dr. Rauh and Professor Meesmann

Dr. Erik von Bahr, Uppsala, Sweden: As previously reported, I have been able to produce lenticular opacities of the zonular type in rats by purely dietetic measures which led to rachitic tetany. The only difference in the diet of the rats with uncomplicated rachitis, which did not show lenticular changes, and that of the animals with rachitic tetany, in which lenticular changes developed, was as follows: The calcium-phosphorus ratio of the rachitogenic diet was 4:1; for the rats in which lenticular changes developed it was suddenly altered to 1:1. The result was a lowering of the blood calcium, resulting in some analyses to one-half ~~the normal amount~~.

On the basis of these experiments it cannot be maintained that a parathyroid insufficiency existed to the extent that there was a reduction

in the production of parathyroid hormone; on the contrary, it appears that hypocalcemia was the cause of the lenticular opacities. These opacities were similar to those seen in cases of parathyroprival tetany. In some cases the little punctate opacities disappeared when the tetany disappeared, but more often they progressed.

PROF. ADOLF JESS, Leipzig: Any one observing a presenile cataract which is at all suggestive of tetany should have the calcium content of the blood determined and a careful neurologic survey made of the patient in order to disclose any latent tetany. A routine examination of this sort would make possible the effective treatment with irradiated ergosterol of a multitude of obscure and inexplicable constitutional disturbances due to insufficiency of the epithelial bodies. Hypocalcemia is common in patients with precocious senile cataract, as are other symptoms of tetany. Treatment with irradiated ergosterol markedly improves the general condition. Early diagnosis is advisable in cases of tetany to determine whether prompt treatment with irradiated ergosterol will cause incipient lenticular opacities to retrogress as they did in the experimental rats.

DR. D. K. PISCHEL, San Francisco: A number of years ago experiments were conducted at Stanford University to determine the influence of dinitrophenol on basal metabolism. A marked rise was noted. Great care was requisite in the administration of the drug, as cases of poisoning by dinitrophenol had been observed as far back as the World War in workers in the manufacture of high explosives. The drug was widely used in California to counteract obesity. Patients like to take it. It creates a pleasant feeling of warmth and mitigates hunger sensation.

A year and a half ago several cases of cataract due to dinitrophenol were seen. In such cases, in a dilated pupil one sees a yellowish green reflex and an opacity in the posterior cortex which looks like a thin shell of copper which has been roughly and irregularly scratched. It would be interesting to know whether this lesion has been seen by my colleagues in Germany. Those who are concerned with these interesting investigations of the chemistry of the lens should include the effect of dinitrophenol on the lens in their list for future study.

DR. H. C. MÜLLER, Basel: In Basel my associates and I up to the present have been unable to produce lenticular opacities, such as those described by Dr. Pischel, by the administration of dinitrophenol. So far, our experiments have been few, and we are inclined to believe that the deleterious action of dinitrophenol on the transparency of the lens is due to its causing increased oxidation.

PROF. WALTER LÖHLEIN, Berlin: Dinitrophenol is little used for the cure of obesity in Germany, as physicians have been warned of its dangers by reports published abroad of the development of cataract following its use. However, Vannas, of Helsingfors, recently published a report of a number of cases of cataract due to a dinitrophenol reducing diet.

PROF. JOHANNES OHM, Bottrop: In several cases of eczema due to an idiosyncrasy for scopolamine the administration of calcium relieved the cutaneous condition, although the instillation of scopolamine for the purpose of dilating the pupil did not have to be discontinued.

Docent Dr. Max Bücklers, Tübingen: One must distinguish sharply between postoperative cataracta strumipriva (sic [parathyreopriva? P. H. F.]) seu tetanica on the one hand and zonular cataract on the other hand, which it is claimed develops on a basis of spasmophilia in infants. Only a few of the pictures shown by Professor Meesmann convinced me that he was dealing with true zonular cataract. In this condition one invariably notes a uniformly opaque surface or area in addition to the isolated spokes shown here. It is true that these scattered opacities are located in a zone, viz., a discontinuity layer, but for all that they do not constitute a true zonular cataract.

Prof. Alois Messmann, Kiel: The fact that in a number of cases of postoperative tetany the lenticular opacities began in the form of subcapsular spokes would indicate that similar changes in the lens consisting exclusively of spokes are due to tetany. It certainly compels one to watch for other tetanic symptoms.

Operative Treatment of Glaucoma. Dr. E. Mügge, Eisleben.

Thirteen glaucomatous eyes were operated on by passing a fine diathermy needle through the ciliary body and into the posterior chamber at three or four points. The result was invariably a negative one, in contradistinction to the good results claimed by Skokolik for his ignipunctures. This proves the correctness of Sondermann's conviction of the prime importance of a normally functioning ciliary body in cases of glaucoma. His theory is that the success of operations for glaucoma practiced up to the present has been due in part to the development at the site of operation of blood vessels connecting the ciliary body and the episclera. A combination of posterior trephining and cyclodialysis, as was also suggested by Sallmann, seems to be a suitable procedure. Meller's objection that the trephine opening is closed by a cicatrix is invalidated by the fact that it is still possible for the aforementioned connecting vessels to form. The opening of the iridocorneal angle is another factor in the improved drainage with this combined operation. In 9 glaucomatous eyes on which this type of operation was used the tension was completely reduced to normal, as opposed to 1 failure, although the patients have been followed for only five months. In 1 case in particular repeated trephining by the method of Elliot had been done, with no result. This operation always carries with it the hazard of a rapid progress of any lenticular opacities which may be present. There is less danger of this complication and also less danger of postoperative infection with the new procedure, which is in addition technically simple. That the effect of the operation increases, even after weeks, seems to make logical the assumption of a new growth of ciliary vessels. The function of the ciliary body has a decided significance in the compensation of chronic glaucoma.

DISCUSSION

Prof. Karl Lindner, Vienna: My associates and I use the Sallmann operation as a routine practice, and I believe that it works better than ordinary cyclodialysis. My explanation for its success is, however, a different one. In a fistulized eye there ensues a contraction of the normal vitreous and, with it detachment of the choroid; this tends

to keep patent a filtration space (*Spaltraum*) between the anterior chamber and the suprachoroidal space.

DR. E. MÜGGE, Eiseleben: In a patient with increased intraocular tension in each eye of about equal amount I got a much better result in the eye which I had operated on by the combined method than in the one on which simple cyclodialysis was performed.

MODE OF ACTION OF SOME MEDICATIONS WHICH REDUCE INTRAOCULAR TENSION. PROF. HANS SCHMELZER, Erlangen.

Experimental study of the effect of miotics and other substances by means of the so-called Nadi reaction (tissue-cell-oxidase reaction) and histologic examination of rabbits' eyes were carried out in collaboration with Pfeuffer and Winkelmann. The drugs tested were physostigmine salicylate, pilocarpine, epinephrine, atropine, scopolamine hydrobromide, cocaine hydrochloride, nervocidine and erythrophleine in the usual clinical concentrations, physiologic solution of sodium chloride and various dilutions of molar (according to molecular weight in grams) potassium cyanide. After injection of these drugs into the vitreous there was generally a decided diminution in the indophenol staining reaction of the ciliary epithelium and of the muscles in the anterior section of the globe with more or less marked inflammatory reaction, when the Nadi reaction was applied. After subconjunctival injection of the same drugs there was only occasionally a slightly fainter blue staining reaction and slight, or no, inflammatory changes in the intraocular tissues., After repeated instillations, the indophenol staining reaction remained practically always normal, and only occasionally were slight inflammatory changes noted in the iris and ciliary body. All drugs which lower intraocular tension have a toxic effect on the capillaries and this plays an important role. This study also suggests that the toxic effect may be associated with a direct or secondary lesion of the ciliary epithelium. However, in the case of pilocarpine and physostigmine salicylate, the pupillomotor factor is by far the most prominent.

DISCUSSION

PROF. KARL LINDNER, Vienna: I wish to call attention to the fact that all mechanical procedures involving the vitreous are associated with alteration of its volume, and this must be taken into consideration in any study and interpretation of the problem of glaucoma.

THE PROBLEM OF COLOR ASTHENOPIA. DOCENT DR. KARL VELHAGEN JR., Halle.

A factor of error on the part of the subject enters into tests for color blindness. Normal subjects can be made to give the impression of a color anomaly in three ways: (1) by prolonging the period of observation with the anomaloscope to the point of fatigue; (2) by conducting the examination when the patient is generally physically fatigued and (3) by placing the patient in a chamber with reduced atmospheric pressure, i. e., one in which the oxygen is withdrawn. Administrative agencies and official boards would like definite information on some practical matters concerning persons with color asthenopia.

Is a subject who has been found by ordinary tests to be capable of correct color perception to be allowed to offer fatigue as an excuse for mistakes in recognition of colors? Is an old employee who has shown himself capable and reliable from this standpoint throughout years of service to be discharged if the tests show color asthenopia? I carried out an extensive series of drastic practical tests on an aviator with color asthenopia (*Klin. Monatsbl. f. Augenh.* **96**: 442, 1936) who passed them with ease. One's decisions must be subjective and include a consideration of the data of tests with various pigments and with the anomaloscope. A person with mild color asthenopia should not be rejected, and one with severe asthenopia should not be accepted. As a general rule the person should be rejected who shows an increased color contrast, whose readjustment time (*Umstimmung*) is short and whose color accommodation time (*Einstellung*) is decidedly above the so-called anomaly equations. The person who makes any really gross errors or many slight ones during the color tests with pigments and who feels quite sure of himself with his false color matchings (*Fehleinstellungen*) should also be rejected. A person already in service should be excluded only in case of crass errors. My experience, especially with color asthenopia due to anoxemia, indicates that an apparently normal subject may show what looks like a pathologically altered color perception under certain conditions. In medicolegal cases one must inquire carefully first of all whether such adverse conditions were actually present or perhaps were merely alleged as an alibi for the patient. The chamber with reduced atmospheric pressure may perhaps be used as a diagnostic aid. The more uncontrollable factors of error one gets to know, the more one must urge that the color signal system, even if it cannot be abolished, should certainly not be extended and applied to other new purposes.

CONGENITAL LYMPHANGIOMA OF THE ORBIT AND FACE AT VARIOUS AGES. PROF. ADOLF JESS, Leipzig.

(This presentation included a demonstration of colored photographs and photomicrographs made in 3 cases of protrusion of the eyeball and secondary hemorrhages into lymphangiomas).

This condition is exceedingly rare, only 23 cases having been reported in the literature up to the present time. Three patients, aged 6 months, 1 year and 9 months and 30 years, respectively, presented the general clinical picture which is described here. On the basis of an abiogenesis the subjects show at birth a definite hypertrophy of one side of the face, generally the left, which is caused by the abnormal formation of lymph vessels. The orbital tissues are involved, and their increase in volume leads to marked proptosis. The lids and conjunctiva present large and small lymphangiomas, which show as clear cysts beneath the skin and mucous membrane. Areas of netlike lymphangiectasis may be seen under the bulbar conjunctiva. In 1 case similar formations were noted in the tissue of the iris. The tumor of lymph vessels spreads over the forehead, stopping at the midline, and advances through the cheek, the lips and the subcutaneous cellular tissue to the chin, pushing the nose to one side and depressing the angle of the mouth. The buccal mucous membrane, the gums and the hard and soft palate may be thickened by lymphangiomatous proliferations and sown with numerous small lymph

vessels. At various periods of life this process is repeated and by pressure on the globe and nerve causes lesions of the optic nerve and exophthalmos with diplopia. It also causes thickening of the lips, the forehead and the cheeks, which may become still more marked as a result of secondary hemorrhages into the lymph spaces from thin-walled blood vessels. Traumatism may cause superficial blood-filled lymph spaces to burst and present as hemorrhagic effusions in the conjunctival sac or in the buccal cavity. It is a question how far the formation of hemangiomas is concerned in this process, although the clinical as well as the histologic picture is suggestive. The only possible treatment consists in early successive excisions, which at once show, by the escape of water-clear fluid from the tissues, the lymph-angiomatous nature of the neoplastic formation. Perhaps if sufficiently dense scars are produced one may be able to prevent or lessen the incidence of transitory swellings and pressure on important organs, especially the eye, as well as of secondary hemorrhages. Quite possibly, although this has not been demonstrated, there may be actual tumor formations in addition to these more passive hypertrophies. Persons subject to this congenital anomaly must avoid as far as possible injuries of the diseased side of the head, general body shock, as in athletics, and any rush of blood to the head which would increase the hazards of the condition by secondary hemorrhage.

Cirrositas Vasorum Retinae. Docent Dr. Max Bücklers, Tübingen.

A man 28 years of age complained of sudden decrease in vision. Ophthalmoscopic examination revealed diffuse edema of the retina, which had resulted, among other things, in a honey-comb (*Bienenwabenmacula*) macula. In addition, there were visible in the periphery groups of miliary aneurysms and extremely fine capillary loops, ectatic in places. In the course of time the edema cleared and local hemorrhages appeared, some of which extended somewhat into the vitreous. There were no connective tissue sheaths (*Einscheidungen*) along the blood vessels, but spastic contractions at various points of the veins produced a rosary-like or sausage-link-like (*"Kettenwurst"*) appearance. The general medical and neurologic examinations gave negative results. There was no evidence of syphilis or tuberculosis. The capillaries at other points of the body were microscopically normal. It was assumed that this condition was an early stage of a disease that was first described by Leber, characterized by retinal infiltrations with miliary aneurysms. The clinical picture speaks in favor of a serious vasomotor neurosis, which up to the time of examination had remained localized, affecting only the retinal vessels. The question is raised whether or not the condition may later develop into massive exudation into the retina (Coats' disease).

Clinical Study of the Vessel Caliber in the Fundus Oculi. Docent Dr. E. Lobeck, Jena.

The retinal vessels in a large number of normal and pathologic eyes were measured. The apparatus used was one made from my plans by Zeiss and previously described at the Heidelberg congress of 1934. It

allows one to measure the caliber of retinal vessels and, simultaneously, the diameter of the disk in a short time, one or two minutes, without having to dilate the pupil. The measurements are carried out in accordance with the so-called heliometer principle and give relative values which are read off in the number of scale divisions calibrated on the apparatus. The simultaneous measurement of vessels and disk under identical conditions of optical adjustment (*Einstellung*) allows one to draw conclusions at once as to their reciprocal relations as well as to those between the retinal arteries and the retinal veins. Thus one may judge quantitatively whether one is dealing with vessels of normal caliber, or whether they are dilated or contracted. In addition, the figures can be made absolute if in the ratio of the diameter of the retinal vessels and the papillary diameter one substitutes the figure 1.5 mm. for the latter, which, as is known, is constant irrespective of conditions of refraction. For clinical purposes, however, this is not necessary. In normal eyes the ratio of the diameter of the retinal vessels to the papillary diameter varies from about 1:11 to 1:17, and that of the diameter of the retinal arteries to the diameter of the retinal veins from about 1:1.25 to 1:1.40. In pathologic eyes both sets of relations may be disturbed. The pathologic conditions include local vascular changes, spasms, thrombosis of the central retinal vein or of a branch, angiomatosis of the retina, arteriosclerosis, nephrosclerosis and albuminuric retinitis. The usual alterations noted on ophthalmoscopic examination were confirmed and expressed quantitatively. In cases of arteriosclerosis alterations in the proportion of the diameter of the arteries to that of veins were at times found in the course of one and the same vessel. In cases of nephrosclerosis, albuminuric retinitis and chronic nephritis a high degree of concentration in the arterioles, or precapillaries, was found. The effect of various drugs on the retinal circulation was studied by this method, which is of practical value because it eliminates a factor of error inherent in all those methods which make use of drops to dilate the pupil and necessitates a consideration of the possible action of homatropine and similar mydriatics on the retinal vessels. Tests were made with amyl nitrite, acetylcholine, theophylline with ethylenediamine and choline. The last-mentioned drug definitely dilated the arteries, whereas the first drug apparently has more effect on the veins. The reactions following the administration of caffeine were even more complicated. All these measurements may be useful in evaluating the effect of treatment of disturbances of the retinal circulation and, for the internist, in the pathologic study of renal disease and "pale" and "red" hypertension.

PERIARTERITIS NODOSA (TUBERCULOSA) OF THE RETINA. PROF. WERNER KRYRIELEIS, Hamburg.

Two cases of my own and 2 reported by other observers are presented. In 1, the condition followed tuberculous iridocyclitis. I am of the opinion that the circumscribed changes in the walls of vessels at the posterior pole are caused by toxins which diffuse through the vitreous from an original inflammatory focus in the uveal tract, penetrate the walls of the vessels and cause a reaction with the protective products of the blood stream. In this pathologic process the nature of the inciting agent, or noxa, is of relatively minor importance.

PRESERVATION OF EYEDROPS WITH THE ESTERS OF *p*-OXYBENZOIC ACID. DR. FRITZ BOCK, Giessen.

The esters of *p*-oxybenzoic acid are widely used in a 0.08 per cent solution for the preservation of eyedrops. Bacteriologic studies show that this concentration is not sufficient to keep eyedrops permanently sterile. A concentration of at least several hundredths more is requisite.

Executive Session, July 7, 1936

On Tuesday, July 7, the members of the society met in executive session. As the members of the jury to award the Graefe medal had received a number of equally meritorious essays and had not been able to decide on the winner, it was agreed not to award the prize this year. Geheimrat Prof. A. Wagenmann announced, to general regret, his decision to resign from the office of secretary, which he had filled for forty years. The chairman expressed the thanks of the society to Professor Wagenmann for his long, faithful and efficient services. The latter was then elected, amid general applause, honorary member of the German Ophthalmological Society. Professor Engelking was unanimously elected his successor. Geheimrat Prof. E. von Hippel found himself obliged to resign from the Executive Committee because of failing health. Prof. F. Schieck was elected in his place.

Book Reviews

Gegenwartsprobleme der Augenheilkunde. Edited by R. Thiel. Price, 16 marks. Pp. 280, with 164 illustrations, 2 colored plates and 21 tables. Leipzig: Georg Thieme, 1937.

The lectures which were delivered in a postgraduate course held at Frankfurt on the Main in February 1937 are now collected and printed in book form. They aim to give information on new ideas and on the present stage of knowledge pertaining to general subjects of importance to ophthalmologists as well as to ophthalmic problems. Since no specialty can exist independently and must be a part of general medicine, those general subjects were selected which have a direct bearing on ophthalmology.

A consideration of the selection of subjects is interesting, as those presented show the trend in present day ophthalmology in Germany. Most of the papers are on general medical and on neurologic topics and are presented by authorities in their branches. Thus, hypertension, essential and malignant (red or pale), is treated by Volhard from the medical point of view and by Thiel from the ophthalmologic point of view. Lampert writes on physicodietetic therapy in its bearing on ocular disturbances.

The chapter on tumors begins with an article by Fischer-Wasels on the sensitivity of the tumor cells to external injury. Then radiation therapy for tumors of the eye and its adnexa is presented by Holfelder, and Gasteiger discusses the indications for this treatment.

A number of important lectures are devoted to tumors of the brain. Kleist writes on the clinical diagnosis of tumors of the cerebral cortex; Pette, on acute inflammatory diseases of the central nervous system and their action on the optic nerves; Olivecrona, on meningiomas of the ethmoid plate; Albrecht, on roentgen diagnosis and treatment of tumors of the brain; Peiper, on the present status of the operative treatment of tumors of the brain with special consideration of the intrasellar and parasellar tumors, and Thiel, on the responsibility of the oculist in the diagnosis and treatment of tumors of the brain.

Bethe writes on the vision of animals without a cerebral cortex and of human beings with disturbed visual cortex; Metzger, on vision for figures and things and the problem of soul blindness; Weigel, on lighting and the oculist, and Jaensch, on the oculist and schools of vision without glasses (Bates).

A series of papers on focal infections are most timely. Gasteiger takes up the role of focal infection in the development of inflammatory diseases of the uvea and of the optic nerve; Voss, the relation of diseases of the tonsils and accessory sinuses to diseases of the eye and of the optic nerve, and Kern, infections of the teeth and jaws as cause for diseases of the eye.

A chapter on ocular paralyses is contributed by Jaensch. Thiel writes on errors in the examination and treatment of glaucoma and on new methods of treatment in ophthalmology.

In the final chapters Felix describes the action of war gases on the eyes; Schlossmacher describes accident insurance from the ocular standpoint, and Gasteiger discusses compensation problems and eugenics.

The reader will find the selection of subjects in this book to be excellent and unusual, quite different from those usually given in the average postgraduate course. The main subjects are: (1) the question of hypertonia, (2) roentgen treatment of tumors, (3) tumors and certain inflammatory diseases of the brain, their treatment with the roentgen rays and by operation and (4) focal infections in diseases of the eye. These are today the subjects of general interest and study. The book also contains a number of important ophthalmic topics.

Professor Thiel is to be congratulated on the selection of the subject matter and on the choice of authoritative collaboration in the presentation of many important borderline subjects. This collection of essays shows that the development of ophthalmology is along the lines of a closer relationship to other branches of medicine. Every ophthalmologist will welcome the appearance of this book and will find its study of great interest and benefit.

ARNOLD KNAPP.

Les arachnoïdites opto-chiasmatiques. By J. Bollack, M. David and P. Puech. Pp. 295, with 76 illustrations. Paris: Masson et Cie, 1937.

This publication constitutes the ninth annual volume of the Société française d'ophtalmologie and maintains the high standards set by its predecessors. Lesions near the chiasm, particularly those around the point of emergence of the optic nerves, are considered. The discussion is based on reports of cases collected from the literature and from previously unpublished records from the neurosurgical service of Dr. Vincent at the Hôpital de la Pitié in Paris. Accordingly, the authors have been able to associate the knowledge of neurosurgeons with that of ophthalmologists and to correlate their findings.

The arrangement of the book is logical, the normal anatomy and histology being dealt with first. The symptoms are grouped under ocular and extraocular. The former comprise modifications of visual acuity, alterations in the visual field and disturbances in the fundi. The latter deal with those revealed by roentgenography and ventriculography.

No characteristic syndrome is produced by arachnoiditis in the region of the chiasma. Visual acuity may diminish slowly, after transient premonitory obscurations, or it may be lost suddenly, without warning. One or both eyes may be affected. Charting of the visual field may reveal almost any known defect. The disks may be normal, hyperemic, swollen or pale. Ocular motor signs are rare, but may include paralysis of the sixth or third nerves. Extraocular symptoms, if present, may include unlocalized headache, somnolence, vomiting or even convulsions. Roentgenograms and ventriculograms are normal.

In discussing diagnosis, the authors consider the inflammatory lesions separately, pointing out differences between the behavior of these lesions and of tumors in the region of the chiasma, chiefly meningiomas of the olfactory nerve and lesser wing of the sphenoid, hypophysial adenomas, craniopharyngiomas, gliomas and meningiomas

of the tuberculum sellae ossis sphenoidalis. The diagnosis is usually made by elimination and can be confirmed only by operation.

In determining the type of treatment, the authors point out the handicaps imposed on the physician by gaps in the knowledge concerning etiology. In the early stages, medical treatment is indicated, consisting chiefly of the use of iodides, salicylates and mercuric cyanide. When vision is threatened, surgical intervention is indicated. The operation of choice is transfrontal exploration and liberation of the adhesions around the origins of the optic nerve. The results are favorable in comparatively recent cases but unfavorable when optic atrophy has become far advanced. The authors stress the importance of operating at the proper time (*au bon moment*), after the conservative treatment has failed to produce results but before the lesions have become too well defined.

The monograph contains all that is known of lesions about the chiasm and should be studied carefully, not only by ophthalmologists but by neurosurgeons as well.

G. M. Bruce.

Chemistry of the Brain. By Irvine H. Page, M.D., Associate Member of the Rockefeller Institute for Medical Research, New York. Price, $7.50. Pp. 444, with 52 tables. Springfield, Ill.: Charles C. Thomas, Publisher, 1937.

In this monograph an attempt is made to bring together the scattered results of innumerable workers in the field of the chemistry of the brain. The author's clinical and chemical experience has rendered him peculiarly fitted for writing a chemical treatise on this complex organ. Since the only other monograph of this kind is that of Thudichum, which was published in English in 1884 and in a revised edition in German in 1901, there is a distinct need for an orientation and a comprehensive summary in this neglected field. Because mental diseases are so common and are an extreme social and economic liability, it is surprising that the interest in the chemistry of the brain has not been more intense. More investigations have been made on cerebrospinal fluid than on brain, the basic tissue of neurology.

The monograph is divided into chapters covering the nature of the various constituents and processes occurring in the normal and in the diseased brain. The chemistry of special senses, nerves and cerebrospinal fluid is intentionally omitted. Sterols, phosphatides, cerebrosides, fats, carbohydrates, nitrogenous substances, gases, vitamins, minerals and enzymes and physical chemistry are discussed. A special chapter on oxidations in the brain, written by J. H. Quastel, is included.

There are certain points in the discussions which are of interest to the ophthalmologist. Since the retina may be considered as an anatomic extension of the brain, one may easily acquire, on perusal of this treatise a comparable idea of the great gaps of knowledge which are missing in retinal chemistry. Of particular interest to the oculist are the short sections on the relation of intoxication, vitamin deficiency, xanthomatosis, amaurotic family idiocy, hepatolenticular degeneration, Niemann-Pick's disease and the Hand-Schüller-Christian syndrome to the chemistry of the brain.

From a narrow point of view, a criticism may be made of the use of the many technical and detailed points in chemistry, which frequently appear to have no bearing on the chemistry of the brain. It is almost impossible, however, to discuss the chemistry restricted to a special tissue without involving the field of organic and biologic chemistry, as the subject is interwoven with allied sciences. A brief treatise usually lacks this method of approach and requires much collateral reading for mental digestion. It is fortunate that the author has this broad outlook.

The ophthalmologist who is especially intrigued with ocular chemistry may read this monograph with difficulty, but with profit.

ARLINGTON C. KRAUSE.

Twenty-Fourth Annual Report of the Ophthalmic Hospitals Section for 1936. Ministry of Public Health, Egypt. Price, 10 piasters. Pp. 44, with many illustrations. Cairo: Government Press, 1937.

This report was evidently compiled in time for the Fifteenth International Ophthalmologic Congress in Cairo, because it contains many illustrations of the various ophthalmic hospitals in Egypt—so-called permanent and traveling ophthalmic units.

During 1936, 4 additional ophthalmic branches were opened in the hospitals in Egypt, 1,133,599 new patients were treated and 344,661 operations were performed. The percentage of blindness among the patients was nearly 6, about the same as in previous years. Eighty per cent of the cases of blindness were due to acute ophthalmia and its sequelae; glaucoma was responsible for blindness in nearly 6,000 cases, and the gonococcus remained the predominating factor in the production of acute conjunctivitis.

Postgraduate instruction was continued during the year. The report includes the records of a large number of interesting cases.

A report of the Ophthalmological Society of Egypt is given, followed by a description of the activities of the local organizing committee for the Fifteenth International Ophthalmologic Congress.

Of the operations performed, about 2,000 were for cataract and over 100,000 for trichiasis. The other operations, 27,000 in number, consisted of 1,182 trephinings, 4,000 iridectomies for adherent glaucoma, 7,774 excisions of the lacrimal sac, 31 operations for ptosis and about 9,000 enucleations, while tenotomy and advancement were done only 24 times. The number of operations for strabismus seems strikingly small, considering that there were nearly 50,000 cases of strabismus observed. Evidently a deviating eye is not regarded as a handicap.

One cannot but admire this wonderful amount of work, done probably under most trying conditions.

ARNOLD KNAPP

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

Honorary President: Prof. F. de Lapersonne, 217 Fauborg St. Honoré, Paris.
President: Dr. P. Bailliart, 66 Boulevard Saint-Michel, Paris, 6e.
Secretary-General: Prof. M. Van Duyse, Université de Gand, Gand, Prov. Ostflandern, Belgium.
All correspondence should be addressed to the President, Dr. P. Bailliart.

International Ophthalmologic Congress

Secretary: Dr. E. Marx, Costzeedijk 316, Rotterdam, Netherlands.

International Organization Against Trachoma

President: Dr. A. F. MacCallan, 33 Welbeck St., London, W., England.

FOREIGN

British Medical Association, Section on Ophthalmology

President: Dr. Stewart Duke-Elder, 59 Harley St., London, W. 1.
Secretary: Dr. Thomasina Belt, 13 Mitchell Ave., Jesmond, Newcastle-on-Tyne.
Place: Plymouth. Time: July 20-22, 1938.

Chinese Ophthalmological Society of Peiping

President: Dr. H. T. Pi, Peiping Union Medical College, Peiping.
Secretary: Dr. C. K. Lin, 180 Hsi-Lo-yen, Chienmeng, Peiping.
Place: Peiping Union Medical College, Peiping. Time: Last Friday of each month.

German Ophthalmological Society

President: Prof. W. Lohlein, Berlin.
Secretary: Prof. E. Engelking, Heidelberg.
Place: Heidelberg. Time: July 4-6, 1938.

Midland Ophthalmological Society

President: Dr. T. E. Ashdown Carr, 34 Charnwood St., Derby, England.
Secretary: T. Harrison Butler, 81 Edmund St., Birmingham, England.
Place: Birmingham and Midland Eye Hospital.

Ophthalmological Society of Egypt

President: Prof. Dr. Sayed Abdel Hamid Soliman Pasha, Faculty of Medicine, Cairo.
Secretary: Dr. Abdel Fattah El Tobgy, 3 Midan Soliman Pasha, Cairo.

Ophthalmological Society of the United Kingdom

President: Mr. Gordon M. Holmes, 9 Wimpole St., London, W. 1.
Secretary: Mr. J. D. M. Cardell, 27 Weymouth St., London, W. 1.

Ophthalmology Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

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* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

OXFORD OPHTHALMOLOGICAL CONGRESS

Master: Dr. C. G. Russ Wood, Hill House, Abberbury Rd., Iffley, Oxford, England.
Hon. Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.
Time: July 7-9, 1938.

PALESTINE OPHTHALMOLOGICAL SOCIETY

President: Dr. Arieh Feigenbaum, Abyssinian Str. 15, Jerusalem.
Secretary: Dr. E. Sinai, Tel-Aviv.

POLISH OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Kapuściński, 2 Waly Batorego, Poznań.
Secretary: Dr. J. Sobański, Lindley'a 4, Warsaw.
Place: Lindley'a 4, Warsaw.

ROYAL SOCIETY OF MEDICINE, SECTION OF OPHTHALMOLOGY

President: Dr. Ransom Pickard, 31 E. Southernhay, Exeter, England.
Secretary: Dr. A. Rugg-Gunn, 35 Harley St., London, W. 1.

SOCIÉTÉ FRANÇAISE D'OPHTALMOLOGIE

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris, 7è.

SOCIETY OF SWEDISH OPHTHALMOLOGISTS

President: Prof. K. G. Ploman, Stockholm, Sweden.
Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö., Sweden.

TEL-AVIV OPHTHALMOLOGICAL SOCIETY

President: Dr. D. Arieh-Friedman, 96 Allenby Str., Tel-Aviv.
Secretary: Dr. Sadger Max, 9 Bialik Str., Tel-Aviv.

TSINAN OPHTHALMOLOGICAL SOCIETY

Chairman: Dr. Eugene Chan, Cheeloo University School of Medicine, Tsinan, Shantung.
Place: Cheeloo University School of Medicine. Time: Last Thursday of alternate months.

NATIONAL

AMERICAN MEDICAL ASSOCIATION, SCIENTIFIC ASSEMBLY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
Secretary: Dr. Derrick T. Vail Jr., 441 Vine St., Cincinnati.
Place: San Francisco. Time: June 13-17, 1938.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY, SECTION ON OPHTHALMOLOGY

President: Dr. Harry S. Gradle, 58 E. Washington St., Chicago.
Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: Washington, D. C. Time: Oct. 9-14, 1938.

AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Frederick H. Verhoeff, 243 Charles St., Boston.
Secretary-Treasurer: Dr. Eugene M. Blake, 303 Whitney Ave., New Haven, Conn.
Place: San Francisco. Time: June 9-11, 1938.

CANADIAN OPHTHALMOLOGICAL SOCIETY

President: Dr. W. Gordon M. Byers, 1458 Mountain St., Montreal.
Secretary-Treasurer: Dr. Alexander E. MacDonald, 421 Medical Arts Bldg., Toronto.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Secretary: Miss Regina E. Schneider, 50 W. 50th St., New York.

SECTIONAL

CENTRAL WISCONSIN SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. L. C. Gardner, 11 N. Main St., Fond du Lac.
Secretary: Dr. G. L. McCormick, 626 S. Central Ave., Marshfield.
Place: Marshfield. Time: May 1938.

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. Edwin B. Goodall, 101 Bay State Rd., Boston.
Secretary-Treasurer: Dr. William P. Beetham, 5 Bay State Rd., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. William D. Donoher, 1930 Wilshire Blvd., Los Angeles.
Secretary-Treasurer: Dr. C. Allen Dickey, 450 Sutter St., San Francisco.
Place: Victoria, B. C. Time: June 21-24, 1938.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. W. Howe, 740 St. Helens Ave., Tacoma, Wash.
Secretary-Treasurer: Dr. Purman Dorman, 1115 Terry Ave., Seattle.
Place: Seattle or Tacoma, Wash. Time: Third Tuesday of each month, except June, July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Frank W. Broderick, 501 Central Trust Bldg., Sterling, Ill.
Secretary-Treasurer: Dr. Thorsten E. Blomberg, 501–7th St., Rockford, Ill.
Place: Rockford, Ill., or Janesville or Beloit, Wis. Time: Third Tuesday of each month.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Secretary-Treasurer: Dr. Andre Cortopassi, 703 Second National Bank Bldg., Saginaw, Mich.
Place: Saginaw or Bay City, Mich. Time: Second Tuesday of each month, except July and August.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. J. H. Judd, 107 S. 17th St., Omaha, Neb.
Secretary-Treasurer: Dr. J. C. Decker, 515 Frances Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Grady E. Clay, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. John R. Hume, 921 Canal St., New Orleans.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. John Hunter McRae, 26 Sheldon Ave., S. E., Grand Rapids.
Secretary-Treasurer: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. C. M. Harris, Johnstown.
Secretary-Treasurer: Dr. C. Wearne Beals, Weber Bldg., DuBois.
Place: Johnstown. Time: May 19, 1938.

STATE

Colorado Ophthalmological Society

President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. John C. Long, 324 Metropolitan Bldg., Denver.
Place: Capitol Life Bldg., Denver. Time 7:30 p. m., third Saturday of the month, October to April, inclusive.

Connecticut State Medical Society, Section on Eye, Ear, Nose and Throat

President: Dr. Charles T. Flynn, 41 Trumbull St., New Haven.
Secretary-Treasurer: Dr. Shirley H. Baron, 309 State St., New London.
Place: New London. Time: February 1938.

Eye, Ear, Nose and Throat Club of Georgia

President: Dr. John King, Thomasville.
Secretary-Treasurer: Dr. Mason Baird, 384 Peachtree St., Atlanta.
Place: Augusta. Time: May 1938.

Indiana Academy of Ophthalmology and Oto-Laryngology

President: Dr. C. W. Rutherford, 23 E. Ohio St., Indianapolis.
Secretary: Dr. Marlow W. Manion, 23 E. Ohio St., Indianapolis.
Place: Indianapolis. Time: First Wednesday in April.

Iowa Academy of Ophthalmology and Oto-Laryngology

President: Dr. H. H. Lamb, American Bank Bldg., Davenport.
Secretary-Treasurer: Dr. B. M. Merkel, 604 Locust St., Des Moines.
Place: Davenport.

Louisiana-Mississippi Ophthalmological and Otolaryngological Society

President: Dr. C. A. McWilliams, G. and S. I. R. R. Bldg., Gulfport, Miss.
Secretary-Treasurer: Dr. Edley H. Jones, 1301 Washington St., Vicksburg, Miss.
Place: New Orleans. Time: Spring, 1938.

Michigan State Medical Society, Section of Ophthalmology and Otolaryngology

Chairman: Dr. F. N. Smith, Grand Rapids Clinic, Grand Rapids.
Secretary: Dr. Dewey R. Heetderks, 26 Sheldon Ave., S. E., Grand Rapids.

Minnesota Academy of Ophthalmology and Otolaryngology

President: Dr. Walter E. Camp, 1918 Medical Arts Bldg., Minneapolis.
Secretary-Treasurer: Dr. George E. McGeary, 920 Medical Arts Bldg., Minneapolis.
Time: Second Friday of each month from October to May.

Montana Academy of Oto-Ophthalmology

President: Dr. Roy Grigg, Bozeman.
Secretary: Dr. A. W. Morse, 507 Phoenix Bldg., Butte.

New Jersey State Medical Society, Section on Ophthalmology, Otology and Rhinolaryngology

Chairman: Dr. Oram Kline, 414 Cooper St., Camden.
Secretary: Dr. James S. Shipman, 542 Cooper St., Camden.

New York State Medical Society, Eye, Ear, Nose and Throat Section

Chairman: Dr. Marvin F. Jones, 121 E. 60th St., New York.
Secretary: Dr. Algernon B. Reese, 73 E. 71st St., New York.
Time: May 10, 1938.

NORTH CAROLINA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. M. Lilly, 302 Old St., Fayetteville.
Secretary-Treasurer: Dr. Frank C. Smith, 106 W. 7th St., Charlotte.
Place: Charlotte. Time: October.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. H. Rosenberger, 221–5th St., Bismarck.
Secretary-Treasurer: Dr. F. L. Wicks, 514–6th St., Valley City.
Place: Bismarck. Time: May 1938.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital, Portland. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. N. Darrell Harvey, 112 Waterman St., Providence.
Secretary-Treasurer: Dr. Linley C. Happ, 124 Waterman St., Providence.
Place: Rhode Island Medical Society Library, Providence. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. George Truluck, Orangeburg.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Kate Savage Zerfoss, 165–8th Ave., N., Nashville.
Secretary-Treasurer: Dr. W. D. Stinson, 805 Medical Arts Bldg., Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. T. E. Fuller, 100 W. Board St., Texarkana, Texas.
Secretary: Dr. O. M. Marchman, 1719 Pacific Ave., Dallas.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. V. P. White, 143½ S. Main St., Salt Lake City.
Secretary-Treasurer: Dr. E. B. Fairbanks, Boston Bldg., Salt Lake City.
Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. M. H. Hood, 505 Washington St., Portsmouth.
Secretary-Treasurer: Dr. Charles T. St. Clair, 418 Bland St., Bluefield, W. Va.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. George Traugh, 309 Cleveland Ave., Fairmont.
Secretary: Dr. Welch England, 621½ Market St., Parkersburg.

LOCAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON EYE, EAR, NOSE AND THROAT

President: Dr. James A. Fisher, 501 Grand Ave., Asbury Park.
Secretary: Dr. William F. McKim, 488 Sanford Ave., Newark.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

Akron Academy of Ophthalmology and Otolaryngology

President: Dr. L. E. Brown, Second National Bldg., Akron.
Secretary-Treasurer: Dr. C. R. Anderson, 106 S. Main St., Akron.
Time: First Monday in January, March, May and November.

Atlanta Eye, Ear, Nose and Throat Society

President: Dr. J. Mason Baird, Medical Arts Bldg., Atlanta, Ga.
Secretary: Dr. Alton V. Hallum, 478 Peachtree St., Atlanta, Ga.
Place: Academy of Medicine, 38 Prescott St. Time: Second Friday of each month from October to May.

Baltimore Medical Society, Section on Ophthalmology

Chairman: Dr. Henry F. Graff, 513 N. Charles St., Baltimore.
Secretary: Dr. Frank B. Walsh, Wilmer Institute, Johns Hopkins Hospital, Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Brooklyn Ophthalmological Society

President: Dr. Walter V. Moore, 1 Nevins St., Brooklyn.
Secretary-Treasurer: Dr. Mortimer A. Lasky, 1 Nevins St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. Ivan J. Koenig, 40 North St., Buffalo.
Secretary-Treasurer: Dr. Meyer H. Riwchun, 367 Linwood Ave., Buffalo.
Time: Second Thursday of each month.

Chattanooga Society of Ophthalmology and Otolaryngology

President: Each member, in alphabetical order.
Secretary: Dr. A. H. Benz, 706 Medical Arts Bldg., Chattanooga.
Place: Mountain City Club. Time: Second Thursday of each month from September to May.

Chicago Ophthalmological Society

President: Dr. Georgiana Dvorak-Theobald, 715 Lake St., Oak Park.
Secretary-Treasurer: Dr. Earle B. Fowler, 55 E. Washington St., Chicago.
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cincinnati Ophthalmic Club

Chairman: Each member, in rotation.
Secretary-Treasurer: Dr. E. R. Thomas, 819 Carew Tower, Cincinnati.
Place: Holmes Memorial Library, Cincinnati General Hospital. Time: 8:15 p. m., third Monday of each month except June, July and August.

Cleveland Academy of Medicine, Section of Ophthalmology and Otolaryngology

Chairman: Dr. Webb Chamberlin, 7405 Detroit Ave., Cleveland.
Secretary: Dr. Walter H. Rieger, Hanna Bldg., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

Cleveland Ophthalmological Club

Chairman: Dr. Paul Moore, Republic Bldg., Cleveland.
Secretary: Dr. G. Leslie Miller, 14805 Detroit Ave., Cleveland.
Time: Second Tuesday in October, December, February and April.

COLLEGE OF PHYSICIANS, PHILADELPHIA, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Charles R. Heed, 1205 Spruce St., Philadelphia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

COLUMBUS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

Chairman: Dr. C. E. Silbernagle, 247 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. D. M. Johnson, 327 E. State St., Columbus, Ohio.
Place: Deshler Wallick Hotel. Time: 6 p. m., first Monday of each month.

CORPUS CHRISTI EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. Edgar G. Mathis, 416 Chaparral St., Corpus Christi, Texas.
Secretary: Dr. E. King Gill, 416 Chaparral St., Corpus Christi, Texas.
Time: Second Thursday of each month from October to May.

DALLAS ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Lester H. Quinn, 4105 Live Oak, Dallas, Texas.
Secretary: Dr. J. Dudley Singleton, 1719 Pacific Ave., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

DES MOINES ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. E. G. Linn, 604 Locust St., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month from September to May.

DETROIT OPHTHALMOLOGICAL CLUB

Chairman: Members rotate alphabetically.
Secretary: Dr. William Fowler, 1424 Maccabee Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

EASTERN NEW YORK EYE, EAR, NOSE AND THROAT ASSOCIATION

President: Dr. J. D. Carroll, 102–3d St., Troy, N. Y.
Secretary-Treasurer: Dr. Joseph L. Holohan, 330 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

FORT WORTH EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Van D. Rathgeber, 1012 Medical Arts Bldg., Fort Worth, Texas.
Secretary-Treasurer: Dr. Charles R. Lees, 306 W. Broadway, Fort Worth, Texas.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

GRAND RAPIDS EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Dewey R. Heetderks, 405 Medical Arts Bldg., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Robert G. Laird, 116 E. Fulton St., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

HOUSTON ACADEMY OF MEDICINE, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. L. Allen, 1215 Walker Ave., Houston, Texas.
Secretary: Dr. George C. Farrish, 1625 Main St., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

INDIANAPOLIS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. C. P. Clark, 24 E. Ohio St., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

KANSAS CITY SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. O. S. Gilliland, 1103 Grand Ave., Kansas City, Mo.
Secretary: Dr. John S. Knight, 1103 Grand Ave., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

LONG BEACH EYE, EAR, NOSE AND THROAT SOCIETY

Chairman: Dr. F. C. Hertzog, 117 E. 8th St., Long Beach, Calif.
Secretary-Treasurer: Dr. Ben K. Parks, 619 Professional Bldg., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

LOS ANGELES SOCIETY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Clifford B. Walker, 427 W. 5th St., Los Angeles.
Secretary-Treasurer: Dr. John P. Lordan, 2007 Wilshire Blvd., Los Angeles.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

LOUISVILLE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. S. Bumgardner, Heyburn Bldg., Louisville, Ky.
Secretary-Treasurer: Dr. Max Bornstein, Heyburn Bldg., Louisville, Ky.
Place: Brown Hotel. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

MEDICAL SOCIETY OF THE DISTRICT OF COLUMBIA, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Earle Breeding, 1801 I St., N. W., Washington.
Secretary: Dr. Elmer Shepherd, 1606–20th St., N. W., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.
Secretary: Dr. Sam H. Sonders, Medical Arts Bldg., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. John E. Mulsow, 231 W. Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. John B. Hitz, 411 E. Mason St., Milwaukee.
Place: University Club. Time: 6:30 p. m., second Tuesday of each month.

MINNEAPOLIS OPHTHALMOLOGICAL SOCIETY

Chairman: Each member, in alphabetical order.
Secretary: Dr. M. C. Pfunder, 645 Medical Arts Bldg., Minneapolis.
Place: Hennepin County Medical Society rooms. Time: 6:30 p. m., fourth Monday of each month, October to May, inclusive.

MONTGOMERY COUNTY MEDICAL SOCIETY

Chairman: Dr. A. G. Farmer, 1040 Fidelity Bldg., Dayton, Ohio.
Secretary-Treasurer: Dr. Rome M. Webster, 663 Reibold Bldg., Dayton, Ohio.
Place: Van Cleve Hotel. Time: 6:30 p. m., bimonthly, first Tuesday from October to June, inclusive.

Montreal Ophthalmological Society

President: Dr. Stuart Ramsay, 1496 Mountain St., Montreal, Canada.
Secretary: Dr. J. Rosenbaum, 1396 St. Catherine St., W., Montreal, Canada.
Time: Second Thursday of October, December, February and April.

Nashville Academy of Ophthalmology and Otolaryngology

Chairman: Dr. Guy Maness, 119–7th Ave., Nashville, Tenn.
Secretary-Treasurer: Dr. Andrew Hollabaugh, Doctors Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to May.

New Orleans Ophthalmological and Otolaryngological Society

President: Dr. R. H. Fisher, Chess and Checker Club, New Orleans.
Secretary-Treasurer: Dr. H. F. Brewster, 837 Gravier St., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

New York Academy of Medicine, Section of Ophthalmology

Chairman: Dr. James W. White, 15 Park Ave., New York.
Secretary: Dr. Rudolf Aebli, 30 E. 40th St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

New York Society for Clinical Ophthalmology

President: Dr. Mark J. Schoenberg, 1160 Park Ave., New York.
Secretary: Dr. Jesse Stark, 45 Park Ave., New York.
Place: Squibb Hall, 745–5th Ave. Time: 7 p. m., first Monday of each month from October to May, inclusive.

Omaha and Council Bluffs Ophthalmological and Oto-Laryngological Society

President: Dr. A. J. Young, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. Delbert K. Judd, 1020 Medical Arts Bldg., Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

Ophthalmological Society of the University of Pittsburgh

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, 351–5th Ave., Pittsburgh.
Time: Second Monday in November, January, March and May.

Passaic-Bergen Ophthalmological Club

President: Dr. John S. Van Winkle, 297 Broadway, Paterson, N. J.
Secretary-Treasurer: Dr. T. A. Sanfacon, 340 Park Ave., Paterson, N. J.
Place: Paterson Eye and Ear Infirmary. Time: 9 p. m., last Friday of every month, except June, July and August.

Philadelphia County Medical Society, Eye Section

Chairman: Dr. Sidney L. Olsho, 235 S. 15th St., Philadelphia.
Secretary: Dr. Edmund B. Spaeth, 1930 Chestnut St., Philadelphia.
Time: First Thursday of each month from October to May.

Pittsburgh Ophthalmological Society

President: Dr. Glendon E. Curry, Westinghouse Bldg., Pittsburgh.
Secretary: Dr. George H. Shuman, 351–5th Ave., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

Richmond Ophthalmological and Oto-Laryngological Society

President: Dr. N. H. Turner, 200 E. Franklin St., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. R. E. Elliott, 78 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Raphael Farber, 280 Monroe Ave., Rochester, N. Y.
Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. Lawrence T. Post, 508 N. Grand Blvd., St. Louis.
Secretary: Dr. Leslie Charles Drews, 508 N. Grand Blvd., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Oscar H. Judkins, 414 Navarro St., San Antonio, Texas.
Secretary-Treasurer: Dr. Wilfred E. Muldoon, 414 Navarro St., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Russell Fletcher, 490 Post St., San Francisco.
Secretary: Dr. Avery Morley Hicks, 490 Post St., San Francisco.
Place: Society's Bldg., 2180 Washington St., San Francisco. Time: Fourth Tuesday of every month except May, June, July and December.

SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. J. A. Wilkinson, Medical Arts Bldg., Shreveport, La.
Secretary-Treasurer: Dr. W. L. Atkins, 940 Margaret Pl., Shreveport, La.
Place: Shreveport Charity Hospital. Time: 7:30 p. m., first Monday of every month except July, August and September.

SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Raymond A. Lower, 407 Riverside Ave., Spokane, Wash.
Secretary: Dr. Louis A. Parsell, Paulsen Medical and Dental Bldg., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Gordon D. Hoople, 110 Medical Arts Bldg., Syracuse, N. Y.
Secretary-Treasurer: Dr. I. Herbert Katz, 212 Medical Arts Bldg., Syracuse, N. Y.
Place: University Club. Time: First Tuesday of each month except June, July and August.

TORONTO ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: A. Lloyd Morgan, Medical Arts Bldg., Toronto, Canada.
Secretary: Dr. W. R. F. Luke, Medical Arts Bldg., Toronto, Canada.
Place: Academy of Medicine, 13 Queen's Pk. Time: First Monday of each month, November to April.

WASHINGTON, D. C., OPHTHALMOLOGICAL SOCIETY

President: Dr. G. Victor Simpson, 1710 Rhode Island Ave., N. W., Washington, D. C.
Secretary-Treasurer: Dr. Frank D. Costenbader, 1726 I St., Washington, D. C.
Place: Episcopal Eye, Ear and Throat Hospital. Time: 8 p. m., first Monday in November, January, March and May.